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Regional Office No.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Upper Colorado Region
Salt Lake City, Utah

Finding of No Significant Impact

For

Glen Canyon Powerplant Uprating

Recommended for Approval:

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Regional Environmental Officer

12/9/82
(Date)

Approved:

Regional Director

12/9/82
(Date)

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Finding of No Significant Impact

Glen Canyon Powerplant Uprating

The proposed action would not constitute a Federal action having significant environmental impacts.

Project impacts are summarized below:

1. Maximum flows from the powerplant in the Colorado River below Glen Canyon Dam would increase from 31,500 cfs to 33,100 cfs. Utilization of the increased capacity from uprating the generators would cause higher flows than those presently occurring approximately 7 percent of the time. These flows would be of short duration (usually less than 4 hours), and would be dampened as they move down the river.

   During periods of increased flows, wetted perimeter along the river between the dam and Lees Ferry would increase by an average of 2 feet horizontally, or 2 inches vertically. This increase in wetted perimeter would not cause any significant erosion of streamside vegetation.

   The present pattern and duration of flows below 14,000 cfs would not be changed from present operations, and the present sources of ground water that support riparian vegetation would not be altered; therefore, impacts on existing riparian vegetation or the terrestrial species that inhabit it would not be measurable.

2. The increase in flows would occur at the high end of the flow pattern and would not affect the minimum flows. The water from the reservoir would come from the same penstocks as at present; therefore, there would be no change in the temperature or the chemistry of the water. Habitat simulation models showed essentially no change in useable area for fish. Based upon this information, no measurable impact is expected on the quality of fishery resources below the dam.

3. Using data cited in paragraphs 1 and 2 above, plus other studies conducted by the U.S. Fish and Wildlife Service and the Bureau, it was concluded that there would be no impact on threatened or endangered species because of the uprating. This was confirmed by the U.S. Fish and Wildlife Service which provided the Bureau with a nonjeapordy opinion on the humpback chub and the peregrine falcon (letter dated April 2, 1982) in compliance with Section 7 of the Endangered Species Act.

4. The proposed uprates would increase the maximum discharge at Glen Canyon Dam by 5 percent over the present maximum and would have no measurable impact on the size or duration of minimum discharges. Operational patterns would continue essentially as historically; therefore, no additional impacts on recreation are expected.

5. There would be no impact on known historical or archeological resources as surveys indicate they are located above the area that would be affected by increased flows.

Approximately 500 copies of the Draft Environmental Assessment (EA) were distributed to the public which resulted in the receipt of approximately 350 letters of comment. Over 50 percent of the comments dealt with the impacts of the present operation of Glen Canyon Powerplant. Of those comments dealing with issues related to the proposed uprating, none were unresolvable. A summary of the comments on the Draft EA and responses to them are attached to the Final EA.

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DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

FINAL ENVIRONMENTAL ASSESSMENT FOR GLEN CANYON POWERPLANT UPRATING

November 1982

Upper Colorado Regional Office
Salt Lake City, Utah

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Glen Canyon Powerplant Uprating

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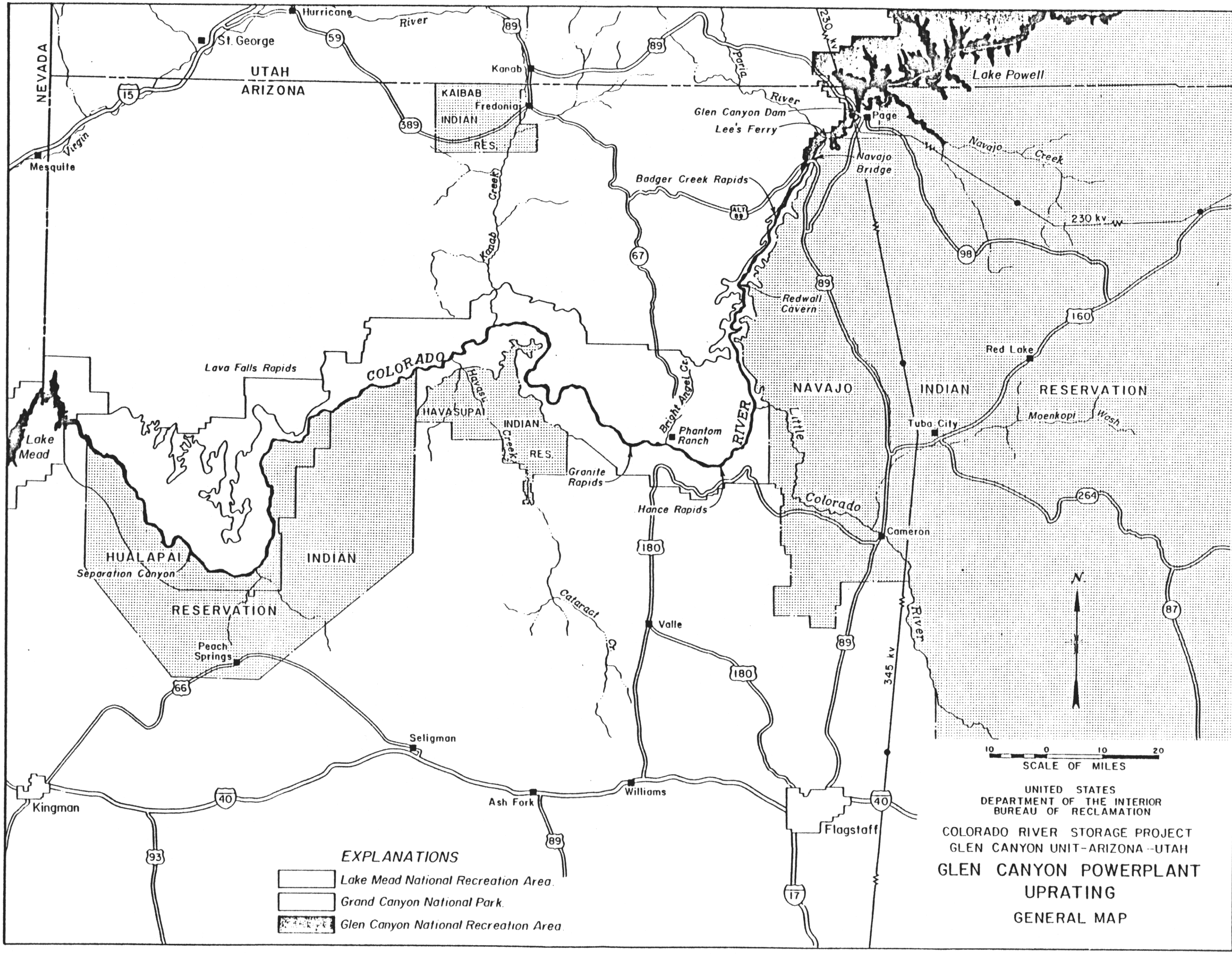
A Western Area Power Administration Colorado River Storage Project General Power Marketing Criteria

B Maximum Release of Water from Glen Canyon Dam for Each Month from September 1964 to September 1981 and Each Day Release Exceeded 28,000 cfs



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER STORAGE PROJECT
GLEN CANYON UNIT-ARIZONA--UTAH

GLEN CANYON POWERPLANT
UPRATING
GENERAL MAP

Final Environmental Assessement
Glen Canyon Powerplant Uprating

CHAPTER I

NEED FOR ACTION

Introduction

The purpose of this environmental assessment is to identify and evaluate the significance of environmental impacts that would occur with the operation of uprated generators at Glen Canyon Powerplant. It is not associated with the Colorado River Storage Project (CRSP) Power Peaking Capacity, Generation at Outlet, Glen Canyon Unit, Arizona study which proposed the addition of generating units to the dam. That study was terminated in October 1981. This assessment is prepared in accordance with the National Environmental Policy Act (NEPA) and current Department of the Interior and Bureau of Reclamation (USBR) guidelines.

Background

On April 11, 1956, the CRSP[1/] and participating projects were authorized by Public Law 84-485 to initiate the comprehensive development of the water resources of the Upper Colorado River Basin. Project purposes were to regulate the flow of the Colorado River; store water for beneficial consumptive use making it possible for the States of the Upper Basin to utilize consistently, within the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively; provide for the reclamation of arid and semiarid land; flood control; and the generation of hydroelectric power as an incident of the foregoing purposes. In order to maximize use of the water and obtain revenues to assist in repayment of irrigation developments, power generating plants were installed or planned at some of the principle storage reservoirs and participating projects. The powerplant at Glen Canyon Dam presently has a capacity of 1,150 MW.

Lake Powell, the principle storage feature of the CRSP, forms behind Glen Canyon Dam and provides nearly 20.9 million acre-feet (MAF) of the 26.2 MAF of water available to produce power in the CRSP reservoirs. (These reservoirs include Fontenelle, Flaming Gorge, Blue Mesa, Morrow Point, and Crystal.) The storage space in the reservoir is utilized to store and release water in order to deliver the quantity of

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1/ The CRSP power market area includes the States of Colorado, New Mexico, Arizona, Utah, and Wyoming in their entirety, all or portions of six counties in Nevada, and the State of California east of 115 degrees of longitude.

water at Lee Ferry1/, Arizona, required by the Colorado River Compact and to Mexico required by the 1944 Treaty with Mexico as provided for in Public Law 90-537. The annual scheduled release at Glen Canyon Dam is either the minimum objective release of 8.23 MAF2/ or, if the projected storage in Upper Basin Reservoirs is sufficient to assure delivery of Compact and Treaty requirements at Lee Ferry without impairment of annual consumptive uses in the Upper Basin, such greater amount as may be required to maintain the active storage in Lake Powell equal to the active storage in Lake Mead. Within these annual releases and as determined by the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs," monthly and daily releases are scheduled to meet contractual obligations to power customers provided such daily releases are sufficient to assure minimum flows for recreation and fish and wildlife.

Beginning in 1975, tests at Glen Canyon revealed that insulation of the generator armature winding had deteriorated in several generators, and was only marginally acceptable in others. An armature coil in generator No. 7 failed in 1976. These conditions led to a decision to begin replacement of the windings in the generators in order to provide reliable service. Rewinding of a generator is a maintenance action and is categorically excluded under the CEQ Regulations for NEPA compliance. Rewinding is expected to occur when the original winding reaches or surpasses expected service life, when winding failure occurs prematurely, or when tests indicate insulation breakdown and possible winding failure may occur.

Since 1976, four generators have been rewound; units seven, two, four, and eight. Rewinding for the first of the remaining four generators is planned beginning in the spring of 1983. Rewinding of the last of those generators should be completed in 1985 or 1986. Although the rewound generators have a higher electrical rating than the original generators, operation is limited to the previous capability (143.75 MW) because of other electrical and mechanical limitations in the generators.

1/ Lee Ferry is defined as a point in the mainstream of the Colorado River 1 mile below the mouth of the Paria River or 1.4 miles below the gauge at Lees Ferry.

2/ Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 944, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona versus California, et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501).

Need for Additional Peaking Capacity

In 1975, a multiobjective planning team was organized to study peaking power resources within the Upper Colorado Region of the Bureau of Reclamation and peaking power needs within the CRSP marketing area. This study group consisted of representatives of Government agencies, private and public utilities and municipalities. The "Power" subteam was chaired by a representative of the Arizona Public Service Company and the planning team report, published in September 1978, identified a projected need for peaking power of slightly over 15,000 MW by the year 2000. This study, plus the Western Energy Expansion Study published in February 1977, became the basis for planning various peaking powerplants within the Upper Colorado Region.

More recently, the Western Area Power Administration (Western) of the Department of Energy, which markets Bureau of Reclamation power, published a report on peaking power needs in the CRSP marketing area. Western's study, dated August 1981, shows a projected year 2000 peaking power need of 11,000 MW, a reduction of about 4,000 MW in year 2000 demand, and indicates that peak demand growth has slowed in recent years. However, even as early as 1990 the projected demand would exceed power that is presently planned to be available.

Conservation measures applied during the next 20 years are expected to reduce the projected market, but are not expected to negate the demand for power arising from an increase in population and development. If these increases in power consumption are to be met, the use of hydropower is usually preferable to nonrenewable fossil fuel supplies or other measures which are either cost prohibitive, in early stages of development, or otherwise infeasible.

CHAPTER II

ALTERNATIVES

This chapter discusses four viable alternatives (no action, uprate generators, uprate generators and restrict generation and flows to present levels, and uprate generators and restrict flows only to present levels) and several alternatives which proved to be nonviable.

No Action (Present Operation)

Selection of the "no action" alternative means that the Glen Canyon generators would not be uprated. To meet increasing loads and new peak demands, however, some other alternative would have to be constructed or utilized. The most likely alternative would be a combustion turbine (burning oil or gas) or an older, less efficient coal or oil-burning steam plant. These alternatives, of course, are not without their own environmental impacts.

Release capability

Glen Canyon Dam is located about 17 miles upstream from Lee Ferry near Page, Arizona and has two separate spillways (one on each side of the dam) with a combined capacity approaching 276,000 cfs. The river outlet works near the left abutment of the dam consists of four 96-inch diameter penstocks with a combined capacity of 15,000 cfs. At the toe of the dam is Glen Canyon Powerplant consisting of eight generators with a combined capacity of 1,150 MW. Water-powered turbines drive the generators and have an output expressed in electrical units of about 170 MW each when the reservoir is full. The maximum water discharge through each turbine is about 4,200 cfs for a combined total of 33,600 cfs.

At a reservoir water surface elevation of 3641 feet, the output of the turbine reaches the maximum capacity of the generator and the corresponding discharge through each turbine is about 3,940 cfs for a combined total of 31,500 cfs. As the water surface elevation rises above 3641 feet, the increase in water pressure and the volume of water that could be released through the turbines would drive the generators beyond their design capability. Accordingly, the turbine gates must be partially closed as elevation increases to avoid exceeding generator capability and overheating and damaging the generators. As these gates close, the amount of water passing through the turbines is reduced until a reservoir elevation of 3700 feet is reached. At this elevation and with plant generation limited to 1,150 MW, the discharge would be reduced to about 27,000 cfs. Therefore, although the maximum possible discharge from the turbines increases with elevation, the present release is limited by the generators to a discharge of 31,500 cfs.

Release patterns

Releases to the Colorado River are normally made through the powerplant, but are also made through the outlet works and spillways when necessary. While bypass of the powerplant is infrequent, maximum releases of 55,700 cfs and 49,000 cfs occurred in 1965 and 1980, respectively. Table 1 shows monthly releases in acre-feet between October 1970 and July 1982 that have occured from the dam. These releases are influenced by factors such as operation for river regulation, storage, Lee Ferry water delivery obligations, power generation, spills, and commitments to fish, wildlife, and recreation.

Glen Canyon powerplant was initially designed for peaking power operations and has the capability to vary releases from the established minimum to full powerplant capacity on a demand basis. A discharge of not less than 1,000 cfs is intended during the winter period (approximately Labor Day to Easter). A release of not less than 3,000 cfs is intended during the recreation season (generally Easter to Labor Day). Normally, any low releases occur on weekends or from midnight to 8 a.m. on weekdays. Also, an average of 8,000 cfs is intended from 8 a.m. to midnight on weekdays. The Bureau of Reclamation and Western make a concerted effort not to drop below these minimum releases, however, as system load or the demand for power varies, dispatchers must attempt to balance system generation in response to these variations. The CRSP power system operation includes not only Glen Canyon but also Flaming Gorge, Blue Mesa, Morrow Point, Crystal, and other smaller plants as well as a rigorous power interchange and purchase program with adjacent power systems. As power demand rapidly diminishes, initial attempts by the dispatchers to balance the entire CRSP system sometimes causes Glen Canyon to be cut back too far. This occurs because Glen Canyon comprises about 75 percent of the total generating capacity of the entire CRSP system. The result is that the release at the dam for 1 or 2 hours may be somewhat less than the intended minimum release. As the dispatchers become aware of this problem, they normally will cut back the use of other resources and increase generation at Glen Canyon to compensate for those low releases. As these low flows travel downstream, the overriding effect of higher releases (discussed under Section III.B.) results in flows at Lees Ferry rarely being less than 3,000 cfs during the recreation season. These minimum releases usually occur on weekends or on weekdays during the first 8 hours of each day (midnight to 8 a.m., Colorado time). This pattern is expected to continue.

Operational constraints

The CRSP powerplants are operated as a unit to satisfy power contract obligations. All of the powerplants are included in the dispatch program which develops the best operational pattern for each of the powerplants within institutional, hydrological, and power system operational constraints. Institutional constraints include, but are not limited to, water laws, water rights, compacts, flood control and release criteria for recreation, fish and wildlife. Hydrological constraints include present reservoir storage and estimated future reservoir inflow. Power system operation constraints include power system capability,

Table 1
Monthly Total Glen Canyon Dam Releases
As Measured at Lees Ferry Gauge
Units: 1,000 acre-feet

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Water Year Total
1970	630	706	814	706	445	486	942	900	800	769	773	701	8,672
1971	498	449	671	492	416	640	1,011	926	894	942	876	776	8,591
1972	584	764	937	806	444	378	782	902	863	915	1,005	931	9,311
1973	631	671	1,017	1,207	764	1,095	1,678	648	751	656	567	425	10,110
1974	510	412	333	846	299	388	494	804	914	1,226	1,213	826	8,265
1975	602	710	564	768	556	508	459	892	987	1,221	1,022	966	9,255
1976	637	425	520	692	742	676	660	1,046	756	766	720	842	8,482
1977	792	898	810	994	471	458	164	206	466	847	1,178	977	8,261
1978	379	390	823	948	601	579	492	648	758	702	1,065	969	8,354
1979	685	671	889	1,018	746	205	342	517	614	860	1,064	686	8,297
1980	618	802	637	604	615	606	863	845	1,472	1,585	1,279	981	10,910
1981	777	936	765	745	640	463	473	553	527	846	903	667	8,295
1982	609	585	838	899	677	509	614	616	634	780	918	617	8,294
1970-1976 Average	585	591	694	788	524	596	861	874	852	928	882	781	8,955
Overall Average	612	648	740	825	570	538	690	731	803	930	968	797	8,854
1977-1980 Average	643	714	794	868	625	470	491	564	745	937	1,067	816	8,736

generating unit outages for maintenance or emergencies, transmission limits, inadvertent power flow due to adjacent power system operations (loop flows), and power system load (demand). Other constraints include system reserve requirements (including powerpool requirements) and transmission line outages for maintenance or emergencies (including the total interconnected power system).

These institutional, hydrological, and operational constraints impact which generation resources are available, while the amount of generating capacity needed to satisfy power sale obligations is affected by the diversity between the various customer loads as well as climatological conditions and socioeconomic habits throughout the seven State area (Arizona, California, Nevada, New Mexico, Utah, Colorado, and Wyoming). Inadvertent power flow or loop flow, which is constantly changing, also has a major effect on the generation patterns at each powerplant because loop flow can increase transmission system loading. It may be necessary to increase or decrease generation at Glen Canyon or other plants to avoid area blackouts due to overloaded transmission system facilities as a result of loop flow. The long term effects of these factors on the total monthly releases from Glen Canyon are illustrated in Table 1. Similar releases are expected to continue in the future.

Reserve capacity requirements

To assure continuity of electric service, reserve capacity is set aside for use in the event a generating unit is lost to the system. CRSP has typically reserved an amount equal to about 10 percent of its load which requires maintaining about 135-140 MW reserve. Western belongs to Inland Power Pool which, among other things, provides for reserve sharing.

Marketing

Glen Canyon power is marketed by Western in conjuction with other Colorado River Storage and Participating Project electrical resources. "General Power Marketing Criteria" as published by Western is presented in Attachment A.

In developing capacity and energy available to be marketed, applicable Federal legislation, inter-state compacts, international treaties, and "Criteria for Coordinated Long Range Operation of Colorado River Reservoirs" must be met. These "laws of the river" comprise the governing authority for storage and release of power-producing water from reservoirs in the Colorado River Basin.

Depending on anticipated future hydrologic conditions, power from the hydro resource is placed under short or long-term contract in accordance with Article 4 of the "Marketing Criteria." Peaking power (capacity without energy) is normally offered for sale on a season-by-season or monthly basis. Hydrologic conditions, however, may support sales extending over a longer period.

Peaking capacity is offered to and placed under contract with power customers under the following terms and conditions:

a. Capacity is available with energy up to 50 percent monthly plant factor.

b. All energy delivered with peaking capacity must be returned on or before September 30 each year unless mutually agreed otherwise.

c. Return of energy shall be at rate and amount as agreed between the customer and the United States.

d. The capacity charge is the same rate as set forth in the firm power schedule of $1.655 per kilowatt month.

e. Delivery conditions are set forth in the General Power Marketing Criteria (Attachment A).

Peaking capacity is marketed up to the rated generator capacity at seasonal reservoir levels less the required reserves.

Uprate Generators (Recommended Plan)

At the time of design, Glen Canyon's generator capacity of 143.75 MW fell within the capability of the turbine and fit the benefit-cost criteria at the time. Now the value of capacity is significantly greater, and changes in the economic conditions make a closer fit to the turbine worthwhile.

Uprating of the generators at Glen Canyon Powerplant would be primarily taking advantage of a low cost opportunity to provide additional capacity at an existing facility, provide opportunity to correct existing equipment problems, and contribute to increased flexibility in the operation and maintenance of Glen Canyon power facilities.

Description of uprating

Modification or replacement of equipment that would enable operation beyond present equipment capacity is referred to as an uprating. Existing transformation (transformers) and transmission facilities for the Glen Canyon Powerplant can carry additional power, and the power equipment for each unit, except the generator, has capability in excess of 167 MW. The turbines also have a maximum capability slightly above 167 MW; therefore, the most logical level of uprate is about 167 MW per unit.

Uprating each of the eight generators from its present rating of 143.75 MW to 167.00 MW would include replacing or reinsulating field windings, strengthening rotor arms, and making minor mechanical modifications such as changing the fan assembly to increase airflow cooling (Figure 1). The work would be planned to coincide with scheduled maintenance activities and would probably extend into 1987. The uprating would increase powerplant capacity from 1,150 MW to 1,336 MW.

Operation with uprates

Uprating the generators would not provide the opportunity to significantly alter the operation of the Glen Canyon Powerplant or the marketing of Glen Canyon power. Water discharge through the turbines would be the same as historically except for periods when the lake is above elevation 3641 feet. At lake elevation 3641 feet and above, the turbine discharge, as previously discussed, could be greater than previous turbine discharge and would reach a maximum of 33,100 cfs at lake elevation 3693 feet for an increase of about 5 percent above the present maximum release. Existing operational and marketing criteria would still apply.

To illustrate the effects of the power system operation on releases below Glen Canyon, a flow duration curve was prepared and is shown in Figure 2. Hourly releases from Glen Canyon Dam were ranked from highest to lowest and then plotted against the percentage of time when that release was equalled or exceeded during an entire water year. This plot is shown by the solid line using water year 1979 data. Water year 1979 was selected because the annual release of 8.5 MAF is generally representative of a minimum 8.23 MAF water year and, in addition, the lake elevations and power demand were such that a maximum release of 31,500 cfs occurred through the turbines. The graph shows that releases of 24,000 cfs were equalled or exceeded 10 percent of the time; 10,000 cfs was equalled or exceeded 50 percent of the time; and 2,500 cfs was equalled or exceeded 90 percent of the time.

The dashed line shown on Figure 2 represents the anticipated change in the flow duration curve as a result of the proposed uprating. Assuming that lake elevations would be high enough to allow increased releases, flows higher than 25,000 cfs would occur approximately 7 percent of the time, and peak flows in excess of 31,500 cfs would occur approximately 2 percent of the time. The figure also shows that the magnitude and duration of flows less than 14,000 cfs would not be affected.

The percent of time that certain discharge levels are exceeded depends on several variables that are difficult to predict. However, the plant operates in the range of its maximum capacity about 2 percent of the time as shown on the flow duration curve (Figure 2). This percentage is not expected to change with the proposed uprating.

Since the total water released cannot be increased, water released during the higher peak releases is made up during times when energy

FIGURE 1

HYDROELECTRIC GENERATOR

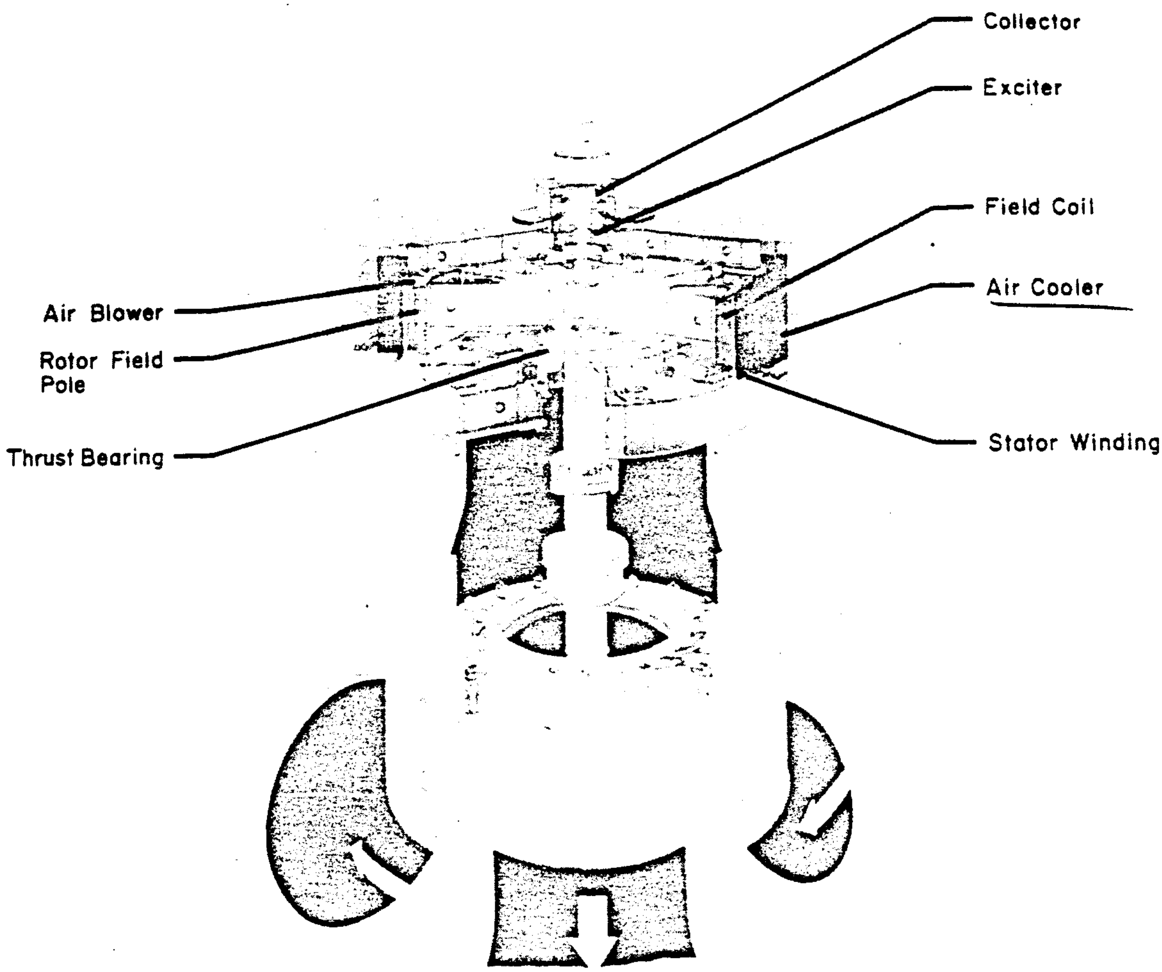
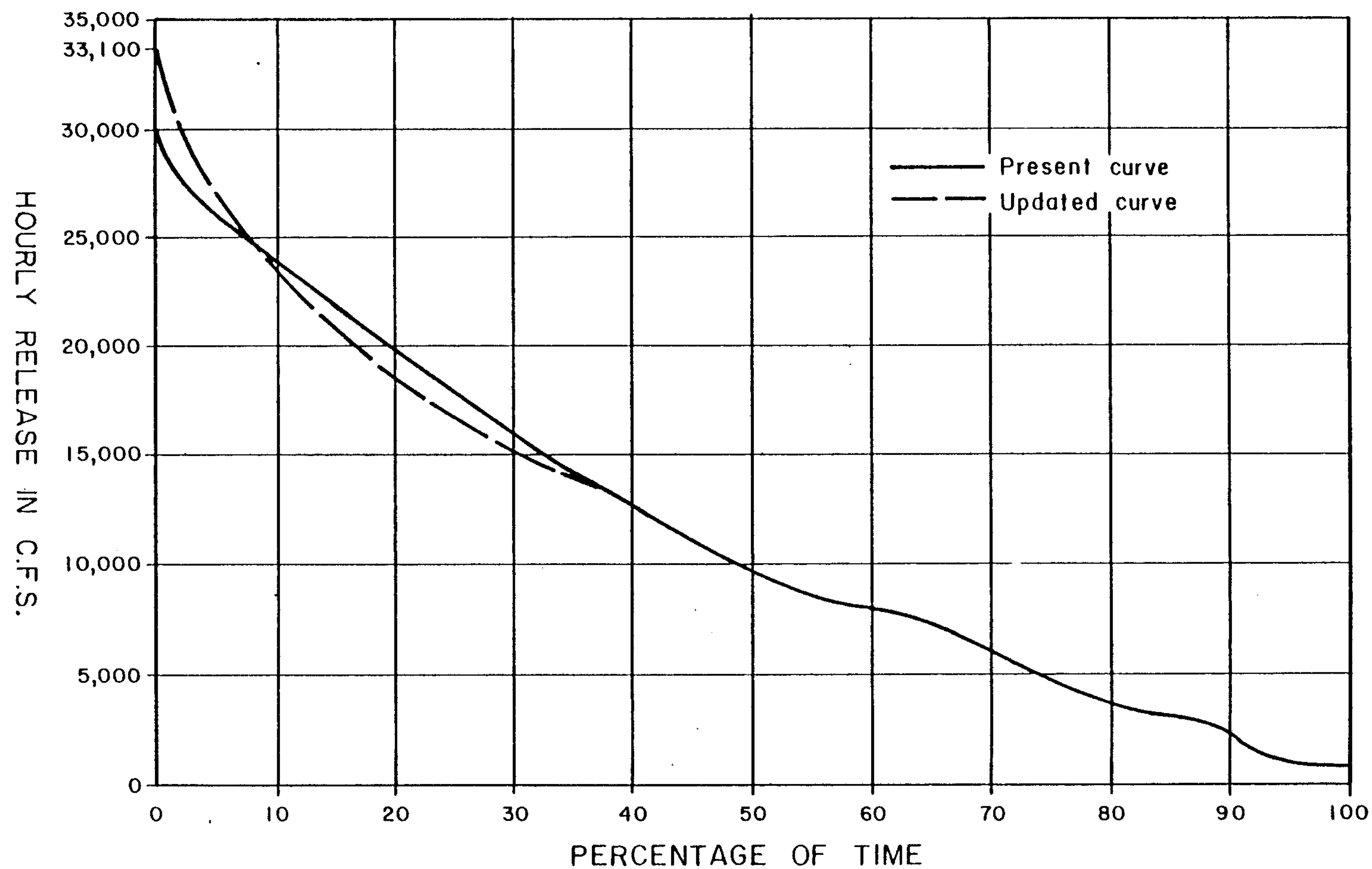


FIGURE 2

GLEN CANYON DAM HOURLY RELEASES
DATA FROM WATER YEAR 1979
FLOW DURATION CURVE



is returned. The assumption made in deriving the curve was that all energy is returned to the system during on-peak hours of off-peak months. This is an oversimplification, however, because inevitably some customers will need to return energy to the system during off-peak hours and may incur penalties imposed by the marketing criteria. Although energy is returned in a random pattern, if flows were at a minimum and the rest of the system could not absorb the return, the exchange would not be permitted and minimum releases would be maintained.

Figure 3 illustrates the relationship between reservoir elevation and powerplant capacity (MW) at various levels of discharge (cfs). The present maximum plant capacity of 1,150 MW is reached at elevation 3,641 feet at a discharge of 31,500 cfs. As reservoir elevation increases the discharge must decrease to limit plant capacity to 1,150 MW. This is shown by following the lower horizontal dashed line (1,150 MW) across the figure from elevation 3,641 feet to 3,700 feet. At a full reservoir (3,700 feet) the maximum plant capacity of 1,150 MW is reached at a discharge of about 27,000 cfs.

With incremental increases in elevation above 3,641 feet the uprating would provide corresponding incremental increases in powerplant capacity. The maximum plant capacity of 1,336 MW would occur at elevation 3,693 feet with a discharge of 33,100 cfs. As the reservoir elevation increases above 3,693 feet the discharge would decrease to limit the plant capacity to 1,336 MW. This is shown by following the upper horizontal dashed line (1,336 MW) across the figure from elevation 3693 feet to 3700 feet. At a full reservoir (3,700 feet) the maximum plant capacity of 1,336 MW would be reached at a discharge of about 32,200 cfs. In terms of increased powerplant capacity the effect of the uprating is shown as the area between the 1,150 MW line and the 1,336 MW line (dashed lines). However, in terms of increased maximum water release, the effect of the uprating is shown as the area between the turbine capability line and the constant 31,500 cfs line (shaded area). Uprating would have no effect on discharge or power production below elevation 3641 feet.

Tables 2 and 3 show the data presented on Figure 3 in tabular form. Table 2 shows the maximum possible discharge from the powerplant after uprating at various elevations between elevations 3641 and 3700 feet. The increase above the existing maximum of 31,500 cfs is also shown and is zero at elevation 3641 feet increasing to 1,600 cfs at elevation 3693 feet. Table 3 shows the effect of the uprating on maximum powerplant discharge with generator limitations before and after uprating. Presently the generator limitation begins to control maximum discharge at elevation 3641 feet. After uprating the generator limitation would begin to control maximum discharge at elevation 3693 feet. The difference between these maximums is zero at elevation 3641 feet and increases to 5,500 cfs at elevation 3693 feet. The utilization time of the increased capacity would be approximately 7 percent (Figure 2) and is related to the probability of future water supply, reservoir elevations, and other parameters. Probabilities of future Lake Powell reservoir elevations are illustrated in Figure 4.

FIGURE 3

GLEN CANYON DAM
POWERPLANT GENERATION AND DISCHARGE

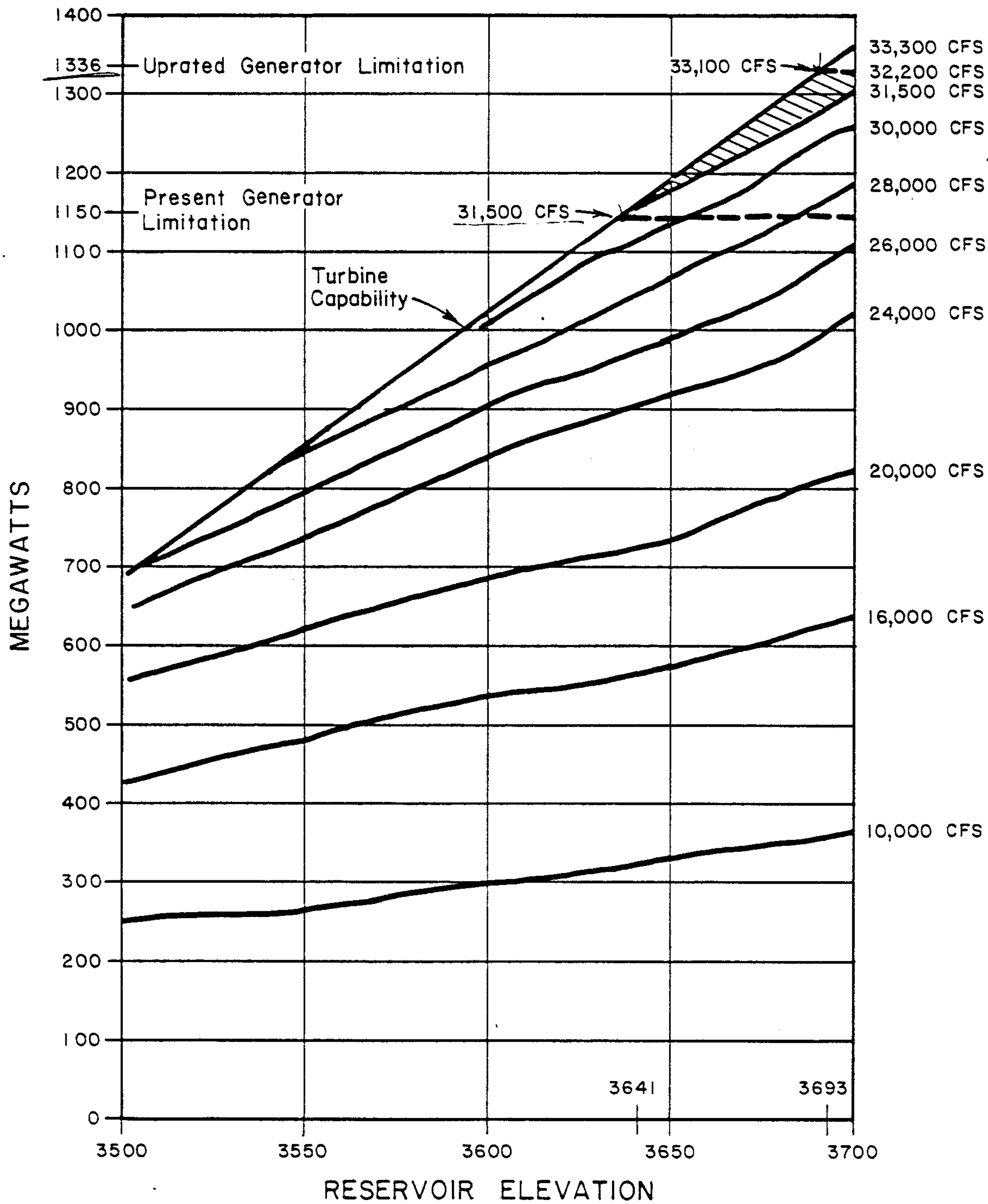


Table 2
Increase in Glen Canyon Dam
Maximum Discharges With Uprating
Units (cfs)

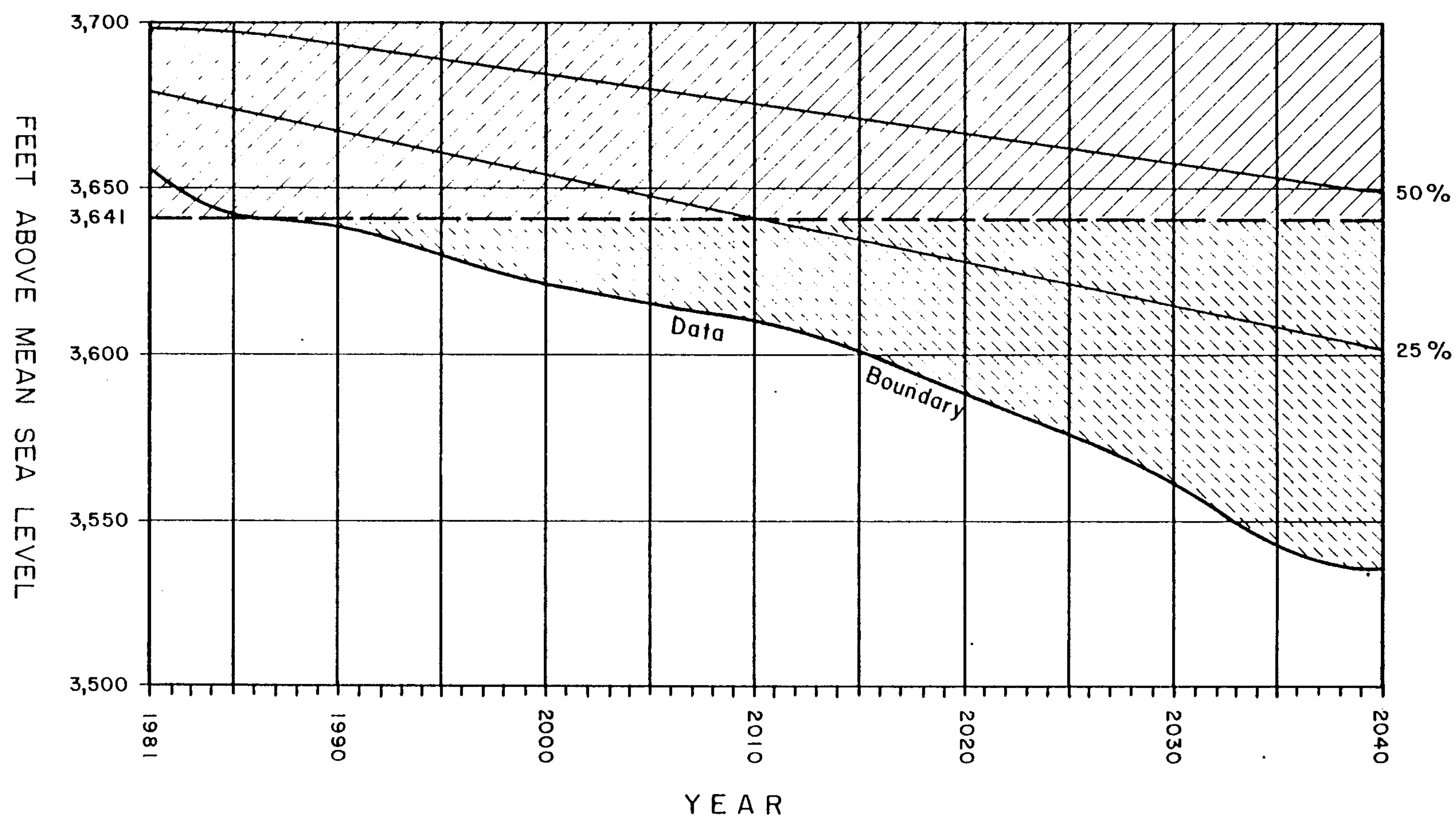
Reservoir Elevations	3641	3645	3650	3655	3660	3665	3670	3675	3680	3685	3690	3693	3700
Maximum Release with Uprating	31,500	31,600	31,800	31,900	32,000	32,200	32,300	32,400	32,600	32,700	32,900	33,100	32,200
Increase Above Existing Maximum Discharge of 31,500 cfs	0	100	300	400	500	700	800	900	1,100	1,200	1,400	1,600	700

Table 3
Glen Canyon Dam
Maximum Discharge With Generator Limitations
Units (cfs)

Reservoir Elevations	3641	3645	3650	3655	3660	3665	3670	3675	3680	3685	3690	3693	3700
Without Uprating	31,500	31,100	30,800	30,400	30,000	29,600	29,300	28,900	28,500	28,100	27,800	27,600	27,000
With Uprating	31,500	31,600	31,800	31,900	32,000	32,200	32,300	32,400	32,600	32,700	32,900	33,100	32,200
Increase	0	500	1,000	1,500	2,000	2,600	3,000	3,500	4,100	4,600	5,100	5,500	5,200

FIGURE 4

PROBABILITIES OF FUTURE LAKE POWELL ELEVATIONS



Probability of use

The opportunity to operate at higher reservoir levels is not always available and depends on inflow into Lake Powell and the amount of carryover storage from previous years, among other factors. Fifteen hydrologic sequences were used in a computer model of the Colorado River system to analyze the probability of future Lake Powell water surface elevations. The mathematical results are plotted on Figure 4. The lines of probability show the chance of Lake Powell elevation being equal to or less than the indicated elevation at certain years in the future. The declining trend of the probability lines is related to anticipated future development of Colorado River water projects and resulting depletion.

As shown in the figure, the probability of Lake Powell elevation being equal to or less than 3641 feet is less than 5 percent in 1985. Conversely, the probability of Lake Powell elevation being equal to or greater than 3641 feet is more than 95 percent for this same year. By the year 2000, this probability is about 85 percent, and by 2040 it is 60 percent. Therefore, there is a significant probability that Lake Powell elevation would be high enough to permit utilization of some portion of the proposed increased capacity at least through year 2040.

The data used to develop the probabilities shown on Figure 4 was the Lake Powell elevation at the end of each water year (September 30) for each of the 15 hydrologic sequences used in the analysis. A prediction of how many days in each year that the reservoir would be above or below 3,641 feet would be very difficult to make; however, Lake Powell elevations normally decline following the runoff and usually reach their lowest levels in March; therefore, the end of September elevation is usually near the median for any given year.

The hydrology used in the analysis from which Figure 4 was developed consisted of (1906-1980) present modified (depleted) flows of the Colorado River. The average annual flow is 11,385,000 acre-feet at the 1980 level of depletion. These flows were further depleted throughout the study period utilizing the current schedule of projected future depletion above Lee Ferry using the table from "Projected Water Supply and Depletion--Upper Colorado River Basin" dated September 1981. The depletion schedule used in the analysis assumed a 5.8 MAF limit of development for the Upper Basin. The delivery obligation at Lee Ferry used in the study was in accordance with the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs." Evaporation and bank losses at Glen Canyon were computed by the CRSP computer model. Evaporation was calculated using monthly evaporation rates and reservoir surface area. Average annual evaporation from Lake Powell is presently estimated to be 600,000 acre-feet. Bank storage change in the reservoir was calculated as 15 percent of the surface storage change.

Benefit cost analysis

The benefits for the Glen Canyon uprating were derived using the same criteria that are used for all types of hydropower developments proposed by the Federal Government. Essentially, the benefits are based upon the estimated annual costs, including fuel, of the most likely alternative powerplant. In the case of uprating Glen Canyon, the assumed alternate plant is a combustion turbine. The derived annual benefits were compared to the estimated annual cost of the uprating to derive the benefit/cost ratio. Also included in this determination was an adjustment for the fact that the uprated capacity would not always be available due to lowered lake elevations. Even though the additional capacity would not always be available because of fluctuating lake elevations, the small cost to uprate makes the benefit to cost ratio approximately 10:1.

No increased costs of operation or maintenance are expected with the uprating. All the facilities for power production are in place and only minor modifications would be necessary to utilize the existing turbine capacity.

In addition, the construction costs of uprating are estimated to be $32 to $41 per kilowatt (kW) as compared to $300.00 per kW for the most likely alternative - a combustion turbine plant.

Uprate Generators and Restrict Generation and Flows to Present Levels

The alternative of uprating the generators at Glen Canyon and maintaining present operations consists of increasing the total plant capacity to 1,336 MW but limiting generation to the present capacity of 1,150 MW and limiting discharge to 31,500 cfs. This would mean utilizing the increased capacity only during maintenance periods when one or two units are being repaired or during unexpected unit outages. Full plant capacity of 1,336 MW would be used only in times of spills or powerplant by-passes. Utilization of the additional capacity in this manner has a benefit/cost ratio of 4:1. The uprating would also provide an opportunity to correct pole heating problems and to replace voltage regulators. For these reasons uprating without use of the additional capacity for peaking power operations has been proposed as a viable alternative.

Uprate Generators and Restrict Flows to Present Levels

This alternative consists of increasing the total plant capacity to 1,336 MW, but limiting maximum discharges to 31,500 cfs. This would mean utilizing some portion of the increased capacity for peaking power operations without exceeding a maximum discharge of 31,500 cfs or during maintenance periods or unexpected unit outages. A release of 31,500 cfs would produce about 1,300 MW at elevation 3,700 feet. Full plant capacity of 1,336 MW would be used only in times of spills or powerplant by-passes. Utilization of the additional capacity in this manner has a benefit/cost ratio of 8:1. This alternative would also provide an opportunity to correct pole heating problems and to replace voltage regulators. For these reasons, uprating without increasing maximum discharges through the powerplant has been proposed as a viable alternative.

Other

Structural alternatives such as additional generating units, coal-fired plants, a reregulation dam, and improved transmission facilities either were not accepted for environmental reasons, do not provide for peaking power, or are not as cost-effective.

Nonstructural alternatives such as conservation and load management were not considered to be a substitute to increasing Glen Canyon generating capacity because even if demand decreased to a point where the energy was not needed, it is likely other more operationally expensive sources (i.e. fossil fuel plants) would be taken out of service before a major hydrofacility because of its superior economic and environmental aspects. Also, some of these alternatives are already functioning to varying degrees in the form of rate structures and, although they represent various levels of effectiveness, were not considered as alternatives to the uprates.

CHAPTER III

EXISTING ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the existing environment between the dam and the backwaters of Lake Mead. It also evaluates the impacts of uprating on vegetation, wildlife, fish, endangered species, the river, cultural resources, recreation, socioeconomic conditions, and floodplains and wetlands. Project effects to these parameters are minor except cultural resources and socioeconomic conditions, which are not affected in any way.

Glen Canyon Dam is located on the Colorado River near Page, Arizona, immediately south of the Utah-Arizona border (Frontispiece). The Glen Canyon National Recreation Area and Navajo Indian Reservation surround the Lake Powell reservoir. Also included in the setting is the 255-mile section of the Colorado River between the dam and the backwaters of Lake Mead. This section of river is located within or bordered by Grand Canyon National Park and the Navajo and Hualapai Indian Reservations. The study area lies within the western portion of the Colorado Plateau and is characterized by numerous canyons, mesas, and plateaus.

Climate is semiarid with a wide temperature range - although precipitation and temperature vary greatly with altitude. Average rainfall is about 4.7 inches and generally occurs as brief summer afternoon thunderstorms or longer periods of lighter rainfall during the winter. Approximately 5 inches of snow falls at higher elevations, and temperatures at Page, Arizona, range from 103° F in the summer to 3° F in the winter.

Vegetation and Wildlife

Plant communities restricted to the narrow corridor along the Colorado River canyon bottoms are classified as riparian. The surrounding land supports desert vegetation which occasionally reaches the river's edge. The riparian zone is river dependent and therefore restricted to the pre-dam flood terraces composed of fine silt and sandy alluvium. Initial post-dam colonization of these terraces was by the exotic species of tamarisk (salt cedar) and the native species of coyote willow. These two species are presently alternating for the dominant role in the canyon while seep willow and arrow weed are subdominant species. Other common plants include red brome, scouring rush, and dog bane. River fluctuations periodically inundate portions of the riparian communities closest to the shoreline and cause erosion of beaches and vegetation. The magnitude of losses to gains is not known, but in some places, vegetation traps and helps reduce the suspended sediment load of the river.

The establishment of perennial vegetation has created a variety of habitats in the riparian zone, resulting in an increase in numbers and diversity of dependent wildlife species. Mammals are represented by rodents, bats, fur bearers, mule deer, and desert big horn sheep. Reptiles and amphibians are common within the vegetation canopy. Birds are the most conspicuous animals in the canyon, the majority being migratory species. Two examples of animals that have adapted and increased in the new environment are discussed below.

Prior to 1963, beaver reproduced in side canyon tributary streams because of high spring runoff in the main channel. Peak flows of close to 180,000 cfs were too damaging to the shoreline habitat to allow permanent habitation. Following closure of the dam, however, vertical river variations stabilized enough to allow a perennial vegetation community (coyote willow) to develop. The presence of this plant (important in beaver's diet) and the moderated spring flows allowed the beaver to colonize the river channel.

Bell's vireo, presently being considered for the U.S. Fish and Wildlife Service Threatened and Endangered Species List, now thrives in the riparian community of the Grand Canyon. Habitat for this species, along with seven other species of birds, (willow flycatcher, yellow warbler, yellowthroat, yellow-breasted chat, northern oriole, blue grosbeak, and brown-headed cowbird) has been improved by enhancement of riparian flora since 1963 (when the river flows were controlled). This group of birds comprises 14 percent of the Grand Canyon's breeding bird population (National Park Service FES 79-80).

The proposed increase in maximum release capabilities would result in only minor increases in wetted area between the dam and Lees Ferry, (Figures 5-8). These figures represent the relationship between flow and wetted perimeter (channel width) at four locations (R-5, R-10, R-15, R-20) between Lees Ferry and Glen Canyon Dam. Figure 9 shows the location of each cross section. Since absolute maximum releases are projected to occur for short durations, the effects of higher flows would rapidly diminish in this reach (see dampening discussion, Section III.B., and Table 4). When flows approach the new maximum of 33,100 cfs, an average of approximately 2 feet horizontally of additional terrestrial environment would be inundated in this reach. Therefore, no significant impact would occur to terrestrial species or their habitat.

The impacts of uprating on existing riparian vegetation are not anticipated to be significant since maximum height increases at Lees Ferry would only approach 2 inches. Impacts on terrestrial habitat and riparian vegetation below Lees Ferry decrease in proportion to distance downstream due to dampening of flows. In addition, increased velocities and their attendent impacts would occur primarily in narrow or restricted portions of the river where rock features predominate. The areas most affected by horizontal movement of water are usually wider areas of slower moving water and also contain the most suitable substrate for riparian growth.

Figure 5

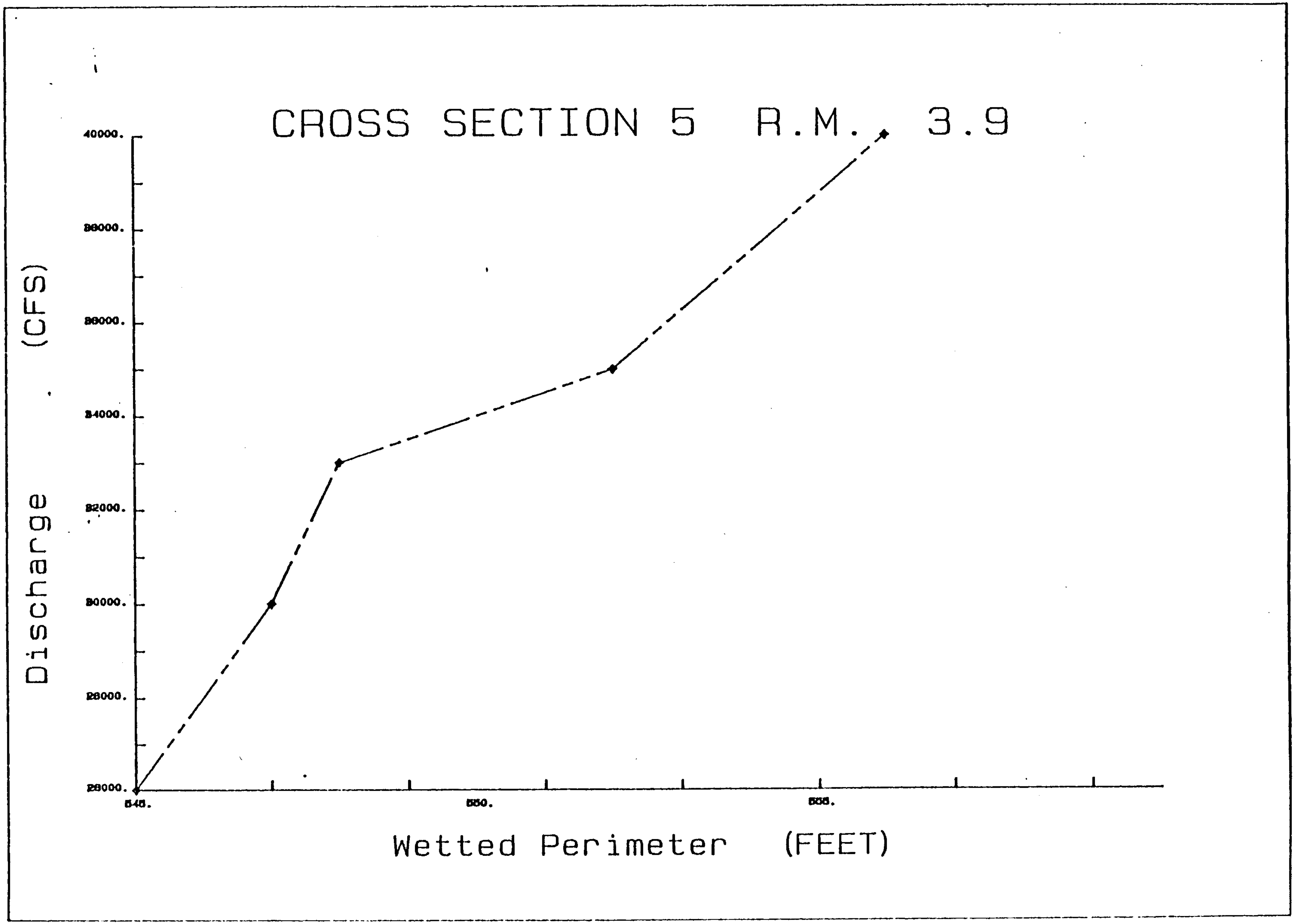

CROSS SECTION 5 R.M. 3.9
Discharge (CFS)
Wetted Perimeter (FEET)
40000.
38000.
36000.
34000.
32000.
30000.
28000.
26000.
545.
550.
555.

Figure 6

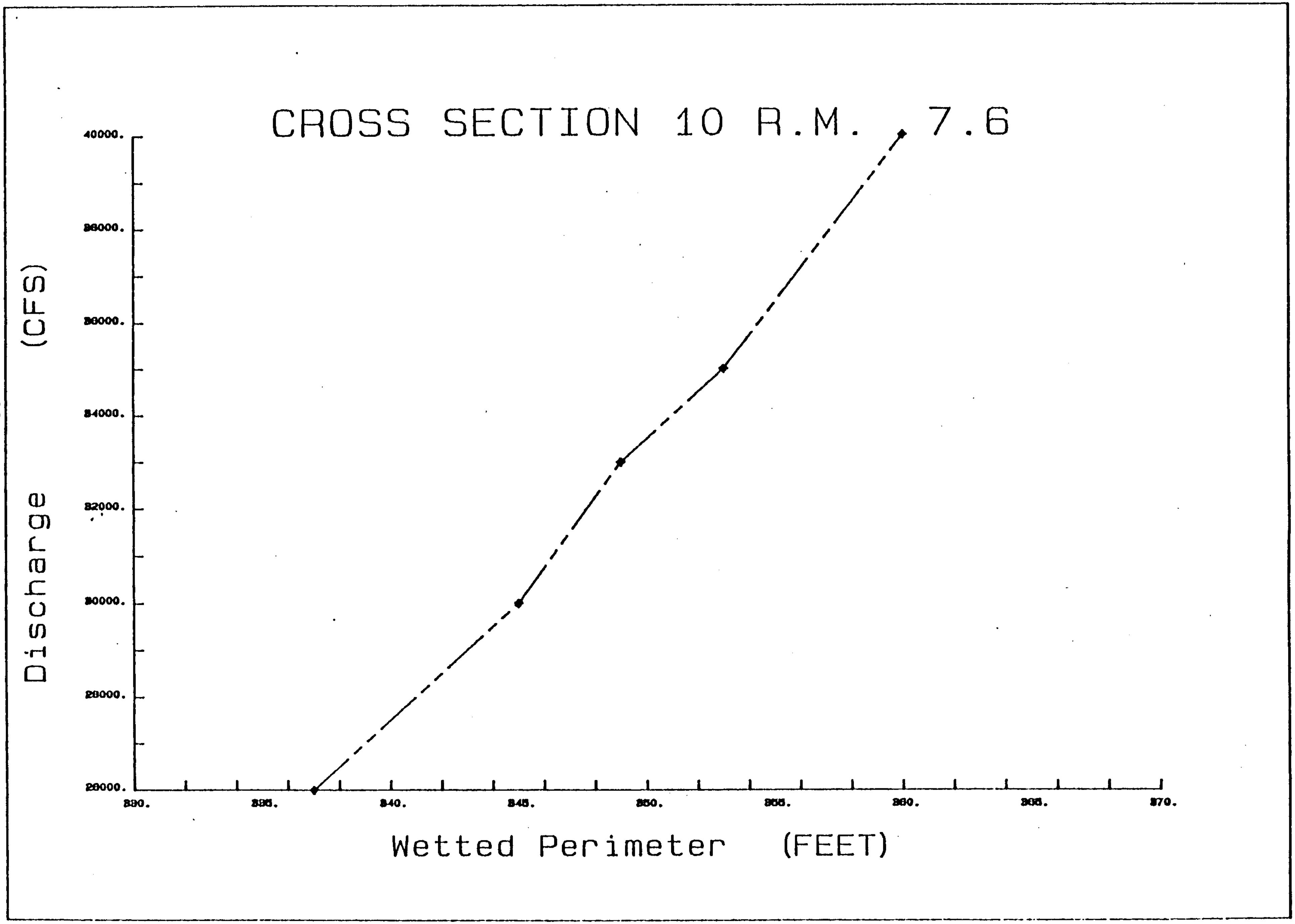

CROSS SECTION 10 R.M. 7.6
Discharge (CFS)
Wetted Perimeter (FEET)
40000.
38000.
36000.
34000.
32000.
30000.
28000.
26000.
330.
335.
340.
345.
350.
355.
360.
365.
370.

Figure 7

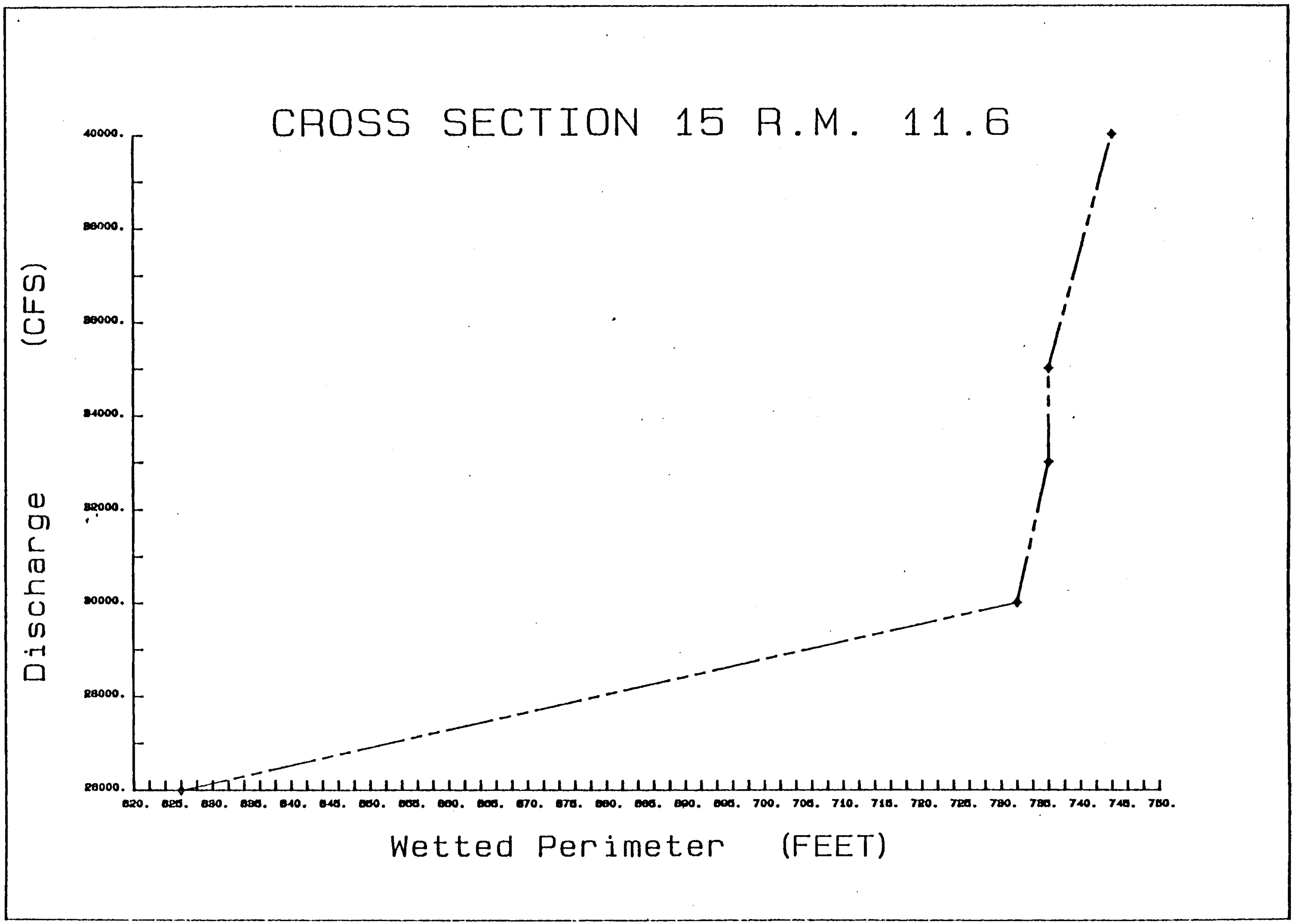
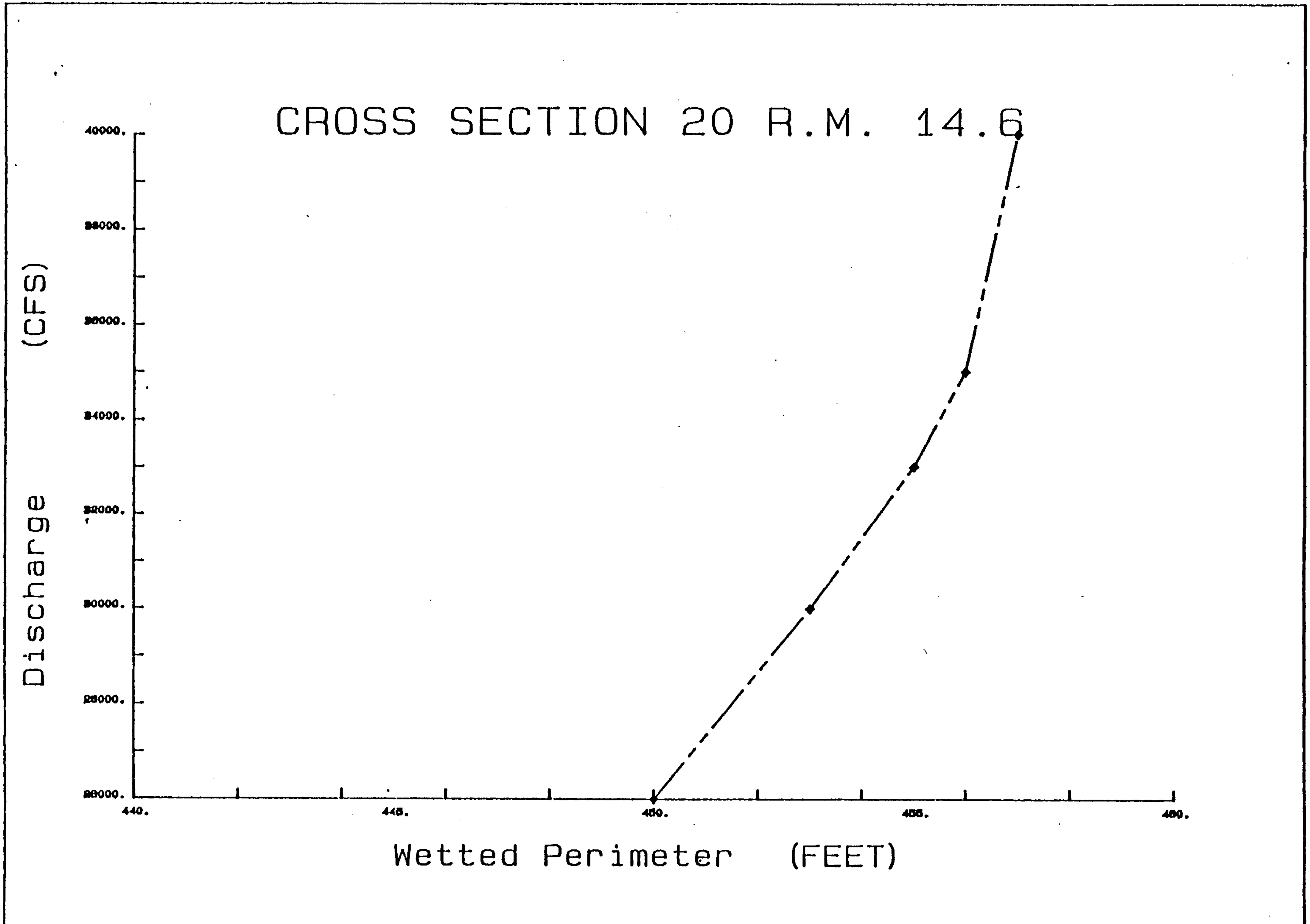
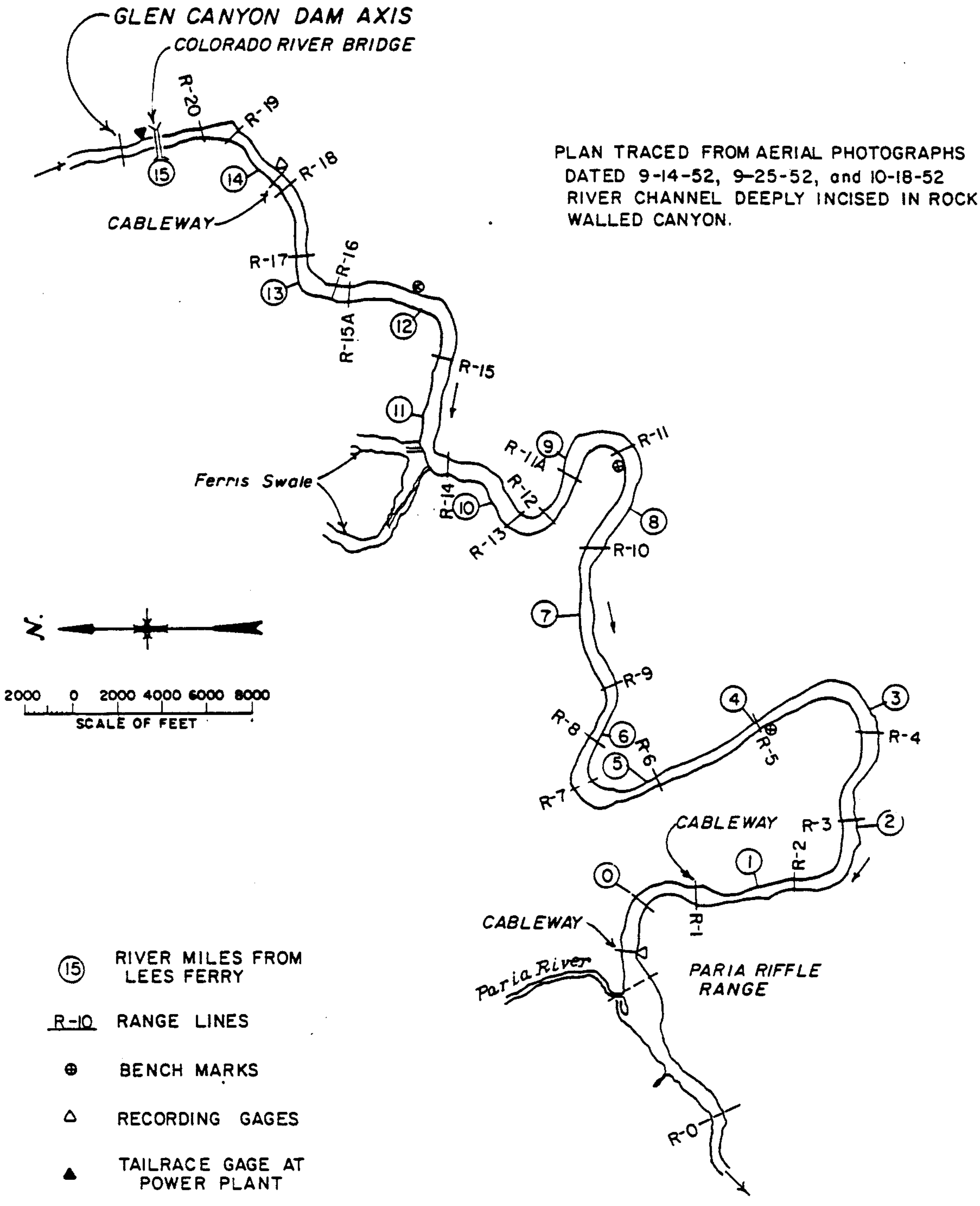

CROSS SECTION 15 R.M. 11.6
Discharge (CFS)
40000.
38000.
36000.
34000.
32000.
30000.
28000.
26000.
620. 625. 630. 635. 640. 645. 650. 655. 660. 665. 670. 675. 680. 685. 690. 695. 700. 705. 710. 715. 720. 725. 730. 735. 740. 745. 750.
Wetted Perimeter (FEET)

Figure 8



CROSS SECTION 20 R.M. 14.6
Discharge (CFS)
Wetted Perimeter (FEET)
40000.
440.
445.
450.

Figure 9



COLORADO RIVER—ARIZONA

LEES FERRY TO GLEN CANYON DAM AXIS

LOCATION MAP

River Environment and River Mechanics

Between Glen Canyon Dam and Lake Mead, the Colorado River falls from about 3,100 feet to approximately 1,200 feet above sea level. More than 150 rapids, some having drops of up to 40 feet, account for most of this elevation loss. Numerous tributaries enter this stretch of river, the principal ones being the Paria River, Little Colorado River, Bright Angel Creek, Tapeats Creek, Kanab Creek, and Havasu Creek.

Prior to construction of Glen Canyon Dam, the average annual spring high flow was approximately 80,000 cfs, with floods occasionally exceeding 100,000 cfs. Beaches in this reach were formed by erosion and deposition of river sediments. When flows moved down river, they would pick up sediment and scour the channel. As water levels subsequently dropped, river velocity would decrease along with transport capacity and new sediment loads would be deposited.

After completion of Glen Canyon Dam, controlled flows hampered this periodic erosion and deposition process. Beaches above the current high water mark now suffer the erosional effects of wind and heavy recreational use, and beaches below the high water mark are continually being eroded by nearly sediment-free, varying releases from Glen Canyon Dam. These releases have a large transport capacity and aggravate the erosion problem, as do flood events occuring from side canyon tributaries. Bank storage also contributes to erosion. When flows are high, some water is temporarily stored in the banks, then as flow is reduced, this water is released and carries sediment back to the river.

The flow of the Colorado River below Glen Canyon Dam varies hourly as the powerplant responds to changes in power load. The diurnal pattern of these variations is fairly consistent with low releases occurring between midnight and 8 a.m. and higher releases occurring from 8 a.m. to midnight. The tendency for high releases to travel faster than low releases results in an eventual overtaking as these flows move downstream. This causes an attenuation or dampening of the amplitude of the release and in the rate of change of flow. This effect can be seen in Figures 10 and 11. There is also a significant amount of river storage in deep reaches of the river where water is slow moving and a tendency for the river bank to store water at high stages of flow. When low flows follow high flows, these reaches and the river bank gradually begin to empty out. If flows are maintained at a low level long enough, the river begins to reach a steady state. As releases are again increased, however, river storage and bank storage are gradually recharged by the higher flows. This gradual emptying and recharging cycle contributes significantly to the dampening effect of the river.

Figure 11 shows the result of rapidly increasing the release from the dam on March 17, 1976. The hourly release from Glen Canyon Dam is shown as a solid line and the recorded flow at Lees Ferry gauge is shown as a dashed line. During the hour beginning at 7 a.m. on that day the release from the dam increased by almost 14,000 cfs. The resulting

Figure 10

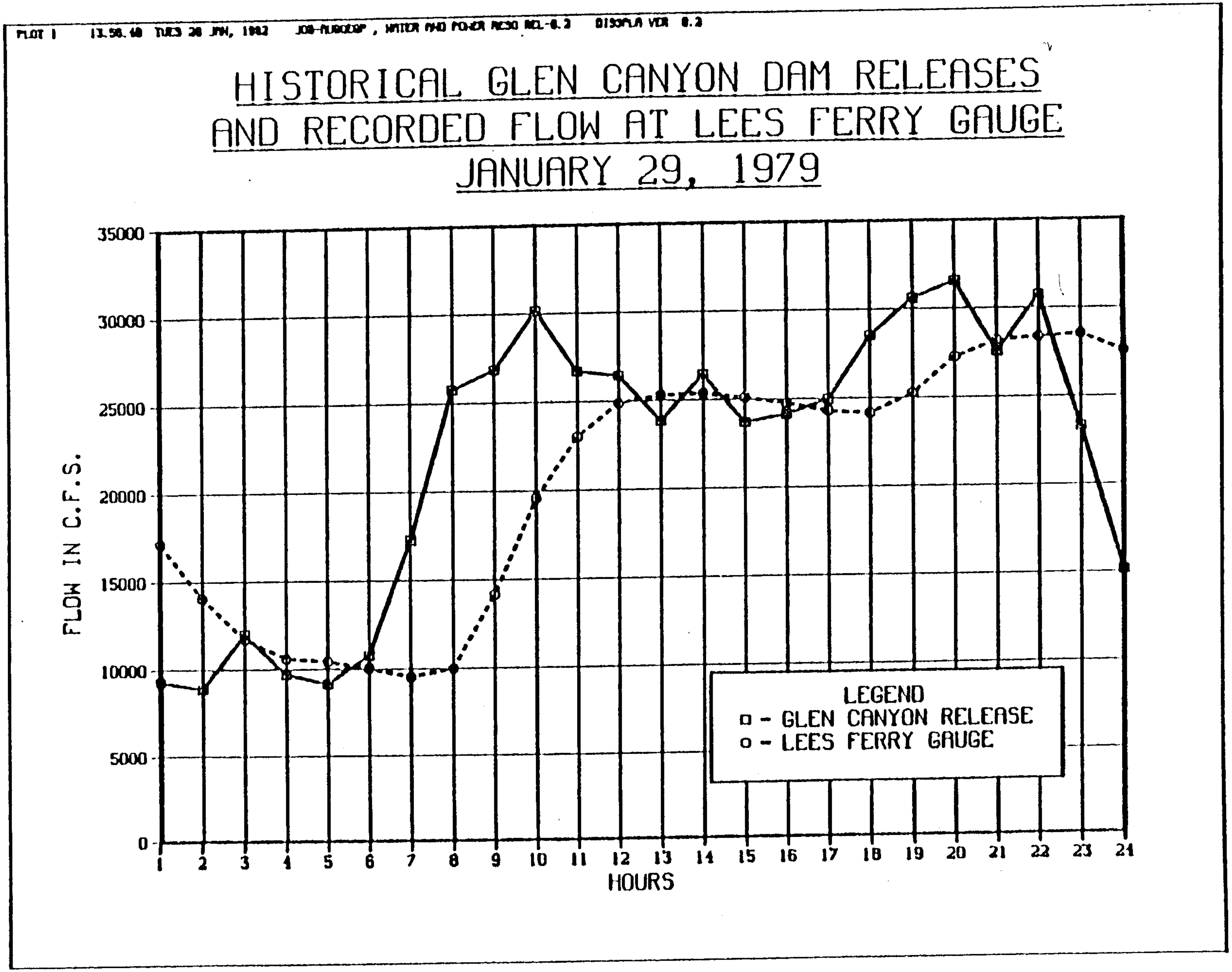
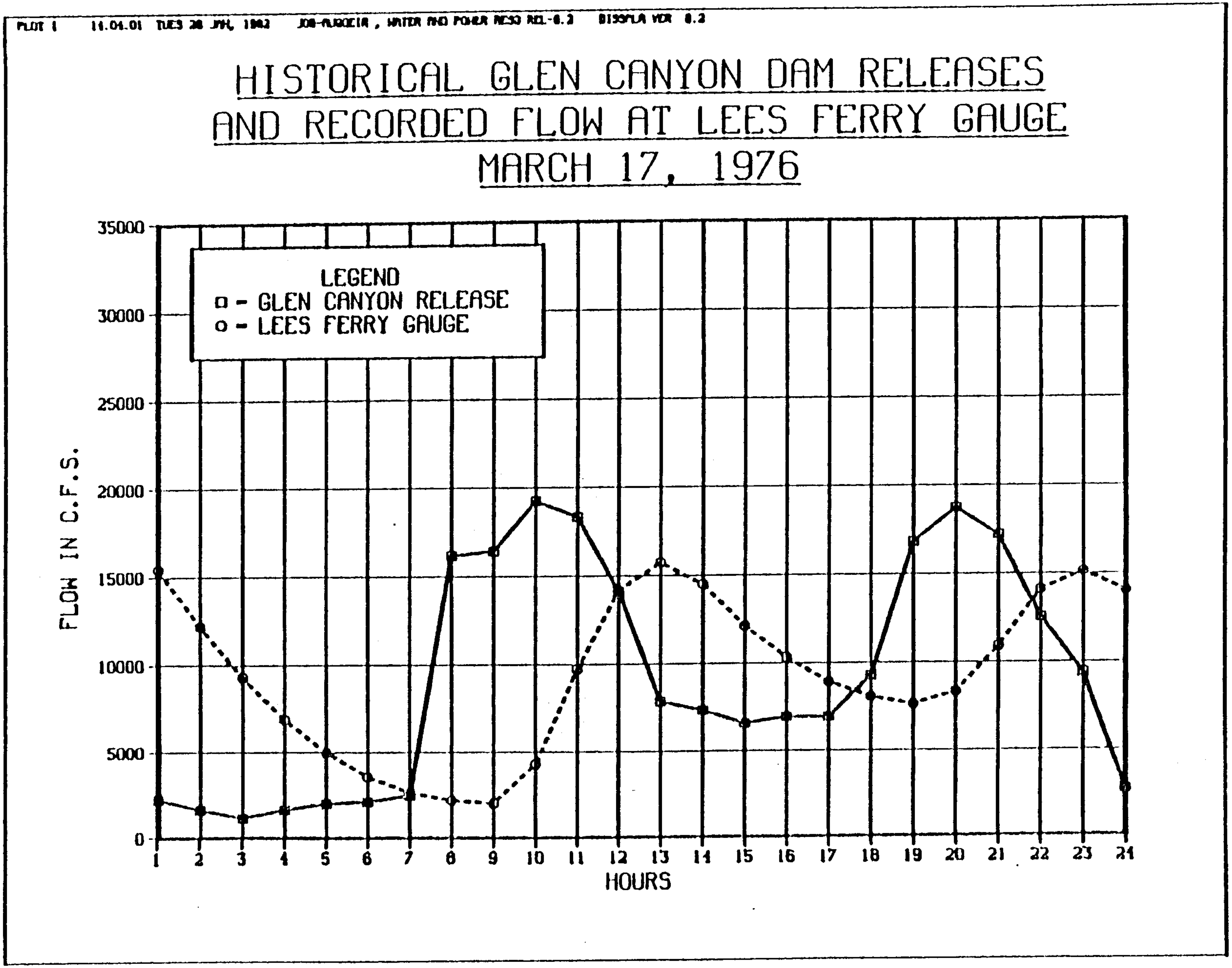

PLOT 1 13.58.40 TUES 28 JAN, 1982 JOB-AUROGRP , WATER AND POWER RESO REL-8.2 DISSPLA VER 8.2
HISTORICAL GLEN CANYON DAM RELEASES
AND RECORDED FLOW AT LEES FERRY GAUGE
JANUARY 29, 1979
FLOW IN C.F.S.
35000
30000
25000
20000
15000
10000
5000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS
LEGEND
□ - GLEN CANYON RELEASE
○ - LEES FERRY GAUGE

Figure 11



HISTORICAL GLEN CANYON DAM RELEASES
AND RECORDED FLOW AT LEES FERRY GAUGE
MARCH 17, 1976
LEGEND
□ - GLEN CANYON RELEASE
○ - LEES FERRY GAUGE
FLOW IN C.F.S.
35000
30000
25000
20000
15000
10000
5000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS

flow at Lees Ferry gauge increased at an hourly rate of only 5,500 cfs. Also, it can be seen that the travel time of the high flows from the dam to the gauge was about 3 hours, and the low flow travel time was about 5 hours.

Figure 10 shows the effect of river dampening on maximum releases from the dam as they reach Lees Ferry. The peak release from the dam at 10 a.m., January 29, 1979, was more than 30,000 cfs while the resulting peak at Lees Ferry was only 25,500 cfs. at 2 p.m. (hour 14). Also, the maximum release on that day of about 31,500 cfs at 8 p.m. (hour 20) resulted in a peak at Lees Ferry of only 28,600 cfs at 11 p.m. (hour 23). Table 4 shows a comparison of peak discharges from Glen Canyon Dam with attenuated flows recorded at Lees Ferry for Figures 10 and 11.

Table 4
Comparison of peak powerplant discharge and maximum flow recorded at Lees Ferry on the same day

Date	Glen Canyon Dam release (cfs)	Flow at Lees Ferry (cfs)
March 17, 1976	19,000 (hour 10)	16,000 (hour 13)
	18,000 (hour 20)	15,000 (hour 23)
January 29, 1979	30,000 (hour 10)	25,500 (hour 14)
	31,571 (hour 20)	28,600 (hour 23)

The proposed increase in maximum possible discharge from the uprating of 1,600 cfs would attenuate to a negligible increase at Lees Ferry and would further attenuate as the flows move downstream.

Fisheries

The Colorado River in this area currently supports a high quality trout fishery. The cold, clear water and nutrients released from the lower levels of the reservoir where temperatures range between 45°-55° F provide the chemical basis for a lush algal growth including species such as Zanichellia and Cladophora. These releases have also established conditions for the propagation of invertebrates and in general have been conducive to trout development over the entire 255-mile distance between the dam and Lake Mead.

Beginning in 1963, the AGFD (Arizona Game and Fish Department) initiated a fish management program for the area by liberally stocking the river below the dam with catchable size rainbow trout. Because of limited access for both the AGFD and fishermen, only the first 15 miles of the Colorado River could be effectively managed or fished. Due to the minimal spawning success of the trout, the State continues to stock fingerlings in order to maintain the fishery.

Initial studies of the AG&F program revealed trout growth was limited due to lack of forage. However, in succeeding years, the clear cold hypolimnetic releases from Glen Canyon Dam scoured finer sediments from the channel and stabilized the bottom strata allowing for the attachment and year-round growth of aquatic plants. To improve trout production, the State introduced a variety of invertebrates to establish a self-sustaining food base. Many of these introductions failed because the animals could not adapt to fluctuating flows. Two species eventually became established and proved to be extremely important items in trout diets. These two animals, a snail (Physa) and a scud (Gamarus lacustris), along with the naturally occurring midge (Chironomidae), are presently the most common trout dietary items. Aquatic plants, mostly the common occurring algae (Cladophora), are also consumed by trout, but are probably taken incidentally.

The development of the fishery to its present-day designation as a "trophy trout fishery" is a direct result of the habitat changes created by the construction and operation of Glen Canyon Dam. Basically, three major changes in the fishery have occurred in the past 19 years. First, trout growth rates are now far superior. Second, although the average weight of creeled trout is much larger, the catch rate is reduced because of fisherman pressure (Table 5). Third, catchable rainbow trout plants have been replaced by plants of fingerling trout.

Most native fish species have been significantly reduced in numbers by daily flow fluctuations, persistently cold water temperatures, and competition from new exotic fish species. Three native species (the Colorado squawfish, bonytail chub, and roundtail chub) have been extirpated in the Grand Canyon. In their place, several exotic species have flourished, the most predominant being rainbow trout (which was purposely introduced) and carp.

Although some losses to the present downstream environment can be associated with the fluctuating flows (such as the stranding mortality of some trout trapped on spawning redds during periods of low flow) trout growth has actually increased during the last several years. The ability of the aquatic habitat to withstand severe flow variations can be attributed to the overall depth of the river. The Colorado River through the Grand Canyon is a series of deep pools, long runs, and short rapids. Some sections of the river are over 100 feet deep. A deep river such as this cuts through a restricted channel and provides protection to the aquatic biota in a number of ways. It is generally accepted that deep pools provide refuge for fish species during times of low flows, and high flows do not significantly alter velocities at depths where fish are found, depth, or river width.

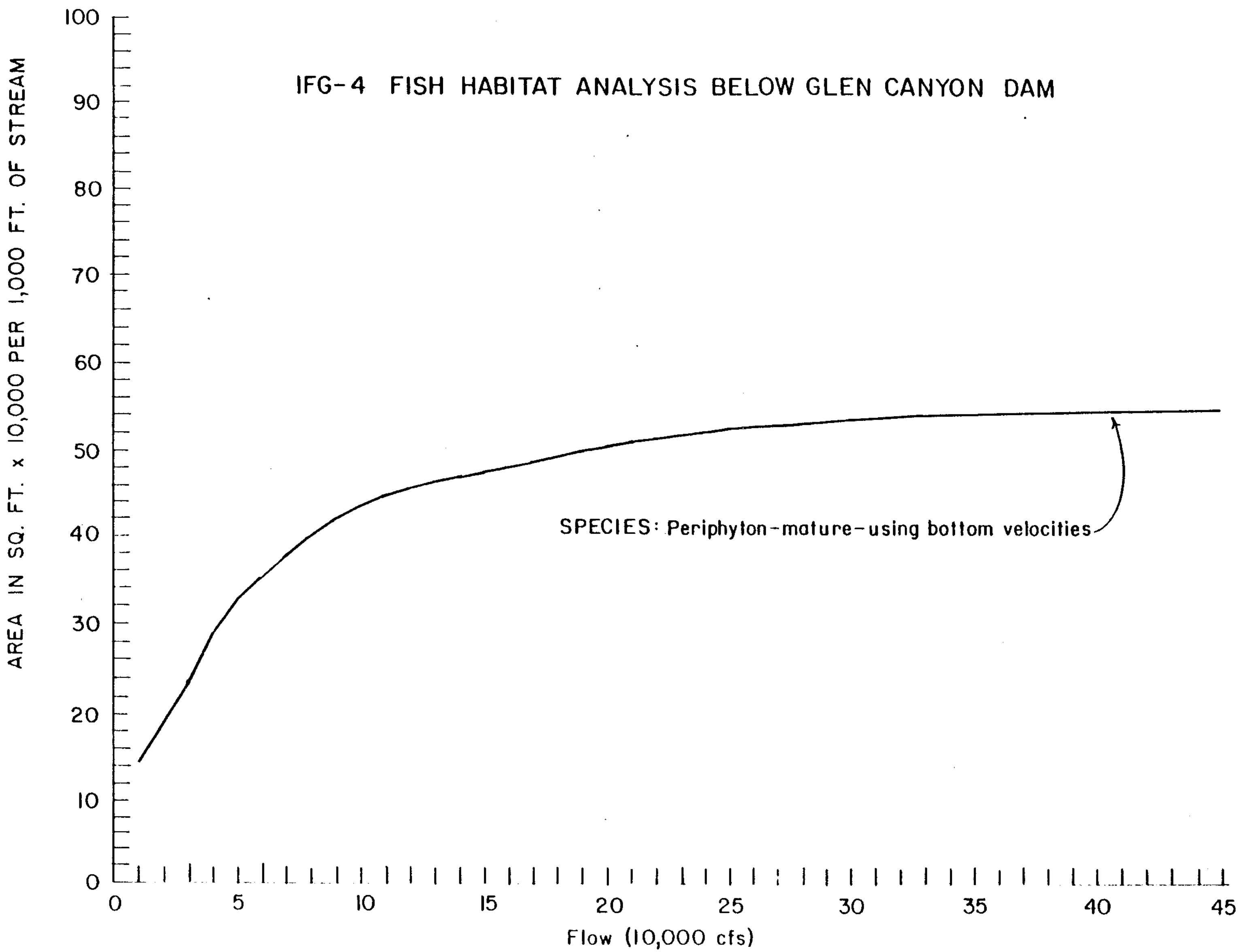
Studies conducted by the Bureau show that sustained low flows at or below 4,000 cfs are most harmful to the benthic community, (Figure 12). These low flows expose large portions of river bottom to the air. If exposed for several hours' duration, the periphyton, macrophytes, and associated invertebrates are lost to dessication. These losses to the

Table 5
Development of the Lees Ferry Fishery, 1968-1978 1/

Year	1963-1964	1964-1965	1965-1966	1966-1967	1967-1968	1968-1969	1969-1970	1970-1971	1971-1972	1977-1978
Angler hours	9,766	15,732	11,424	18,952	22,829	11,717	17,563	13,620	16,595	45,878
Angler days	2,477	4,161	2,681	4,430	4,161	3,337	3,808	3,290	3,581	10,395
Trout caught	10,654	13,512	7,757	7,899	6,597	4,082	8 016	8,421	4,372	7,854
Other species	98	985	138	695	2,638	945	57	24	44	
Fish/hour	1.05	.99	.68	.40	.39	.43	.44	.53	.26	.17
Average weight	.31	.72	.54	.70	.68	.58	.65	.61	1.30	1.70
Trout stocked:	125,800	33,500	26,000	22,100	33,800	47,495	38,536	24,725	4,760	97,880
Catchables	115,800	23,500	7,000	7,100	3,800	7,495	4,550	4,725	4,760	
Subcatchables	110,200									
Fingerlings		10,000	19,000	15,000	10,000	40,000	33,986	20,000		97,880

1/ From Arizona Game and Fish records.

Figure 12



IFG-4 FISH HABITAT ANALYSIS BELOW GLEN CANYON DAM
SPECIES: Periphyton-mature-using bottom velocities
AREA IN SQ. FT. x 10,000 PER 1,000 FT. OF STREAM
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
30
35
40
45
Flow (10,000 cfs)

primary producers and consumers correspondingly have an adverse effect on tertiary consumers (i.e., trout). This loss would be demonstrated as a loss in production such as a reduction in growth rate.

The Bureau is required under the Fish and Wildlife Coordination Act to consider recommendations to minimize, and if possible, avoid, impacts associated with its projects. To date, there is no valid information to show the uprates would affect the fishery. The increased capacity of the uprating would allow for an increase in flow of 1,600 cfs above the present maximum flow at the dam. This increase would come from the high end of the flow pattern as described earlier and would not affect the minimum flows. Water from the reservoir would be released from the same penstocks at the same elevation and would not change temperature or chemistry of the water. Habitat simulation models were run on the existing conditions, and the projected increases showed essentially no change in usable area for trout (see Figure 13). Based upon this information, no significant impact or change is expected to occur to the quality of fishery resources below the dam as a result of the proposed uprate.

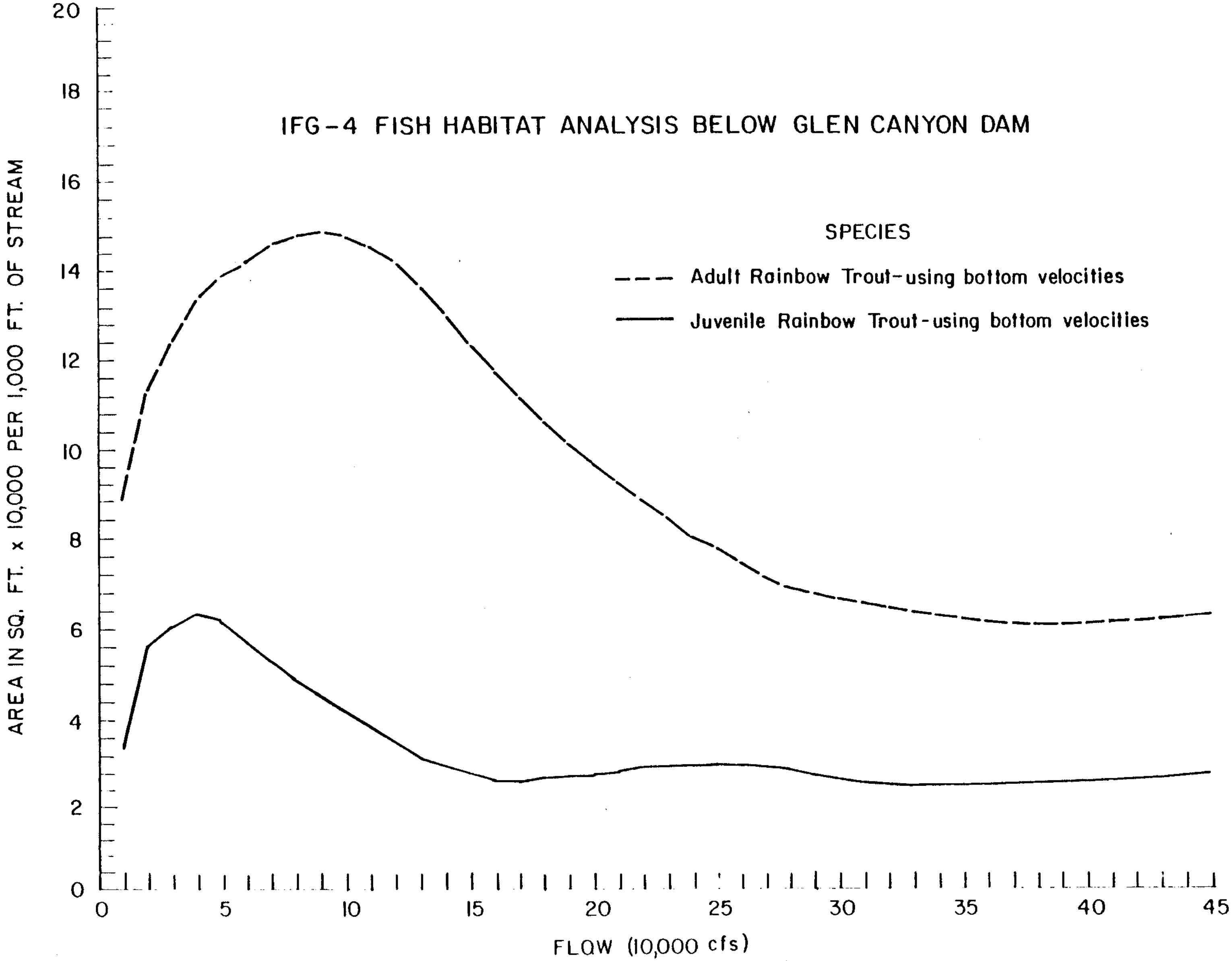
Endangered Species

Two Federally listed endangered species are presently known to occur downstream of Glen Canyon Dam. These are the peregrine falcon (Falco peregrinus) and the humpback chub (Gila cypha). Peregrine falcons would not be impacted by the proposed increase in maximum flow. The U.S. Fish and Wildlife Service Office of Endangered Species has been consulted on the project and provided the Bureau with a "nonjeopardy" opinion on both the peregrine falcon and the humpback chub (April 2, 1982). Information from this opinion and the Colorado River Fishery Project, "Field Studies Part II" (April 1982) as it relates to the humpback chub, is summarized below:

a. The only known population of humpback chubs in the lower basin exists at the mouth of the Little Colorado River in the Grand Canyon and extends several miles above and below the confluence in the Colorado River, as well as upstream in the Little Colorado River. In these areas it is one of the most common species. Reproductive success is related to timing of seasonal runoff - high success when runoff occurs prior to or during spawning and low sucess when runoff occurs after the spawn. Natural reproduction occurs in the Little Colorado River in the first 8 miles upstream from the confluence of the Colorado River and while some impact to incubating spawn and young-of-the-year fish may presently occur, it is not thought to be significant.

b. Water quality of the Little Colorado River may have a more significant influence on chub than depth, velocity, and substrate parameters.

Figure 13


IFG-4 FISH HABITAT ANALYSIS BELOW GLEN CANYON DAM
SPECIES
Adult Rainbow Trout-using bottom velocities
Juvenile Rainbow Trout-using bottom velocities
AREA IN SQ. FT. x 10,000 PER 1,000 FT. OF STREAM
FLOW (10,000 cfs)
0
2
4
6
8
10
12
14
16
18
20
5
15
20
25
30
35
40
45

c. Humpback chubs are known to occur in the Colorado River, but in relatively small numbers. These fish are probably immigrants from the Little Colorado River and are apparently unable to reproduce due to cold water that has a negative effect on the development and survival of fertilized eggs and larvae. Aside from their inability to reproduce, these fish are well adapted to this new environment.

d. There is no evidence for a unique chub population or reproduction in the confluence stratum or the Colorado River. Comparative aerial photographs of main river flows of approximately 27,000 cfs and 37,000 cfs show essentially no difference in the extent of inundation by the Colorado River; therefore, slight increases in maximum flow would not further jeopardize the continued existence of the humpback chub.

Cultural Resources

To determine the presence and nature of cultural resources in the project area, a Class II field survey was conducted between Glen Canyon Dam and Lees Ferry, and a Class I literature search was completed for the area below Lees Ferry. Ten archeological and historical sites were located along the river between the dam and Lees Ferry, including Lees Ferry, Stanton's Road, and a placer mine test site. The survey revealed resources such as petroglyph panels, quarry and camp sites, and small rock shelters. It also showed that use and occupation of the Glen Canyon mainstem was greater than commonly recognized.

Below Lees Ferry, the literature search revealed detailed information on hundreds of historic and archeological sites along the river. Some of the sites (such as Lees Ferry) are significant and currently listed on the National Register of Historic Places but most have not been thoroughly evaluated. No impact would occur to any of these historical or archeological resources as they are located above the area of impact.

Recreation

The 15 miles of river between Glen Canyon Dam and Lees Ferry is used primarily for fishing, boating, camping, hiking, and sightseeing. River oriented recreation within this area accounted for approximately 24,000 visitor days in 1980 with more than 5,000 of these occupied by 1-day commercial float trips. Although the Park Service does not presently limit use within the area, studies are in progress to determine the degree of environmental impact caused by human use.

The stretch of river between Lees Ferry and Lake Mead through Grand Canyon National Park is approximately 240 miles and offers the longest stretch of recreational whitewater in the world. The 1960's and

1970's saw dramatic increases in the demand for whitewater rafting experiences within the park and led to the development of the Colorado River Mangement Plan (CRMP) which currently limits rafting within the park to 169,950 user-days annually (115,500 for commercial use and 54,450 for private use). Other restrictions apply to season of use, group size, trip length, and boat capacity. The economic value of these trips to northern Arizona is estimated to be more than $12 million per year (Flagstaff Chamber of Commerce).

Rafting parties presently experience scheduling and mooring problems related to fluctuating and low flows. Mooring problems result from nightly changes in flows which sometimes leave rafts beached above the water line. Less frequently, high flows may partially flood beach camping areas. Low flows also cause scheduling problems in the form of delays and crowds at the heads of rapids. Safety problems, equipment damage, and injuries sometimes occur when raft operators attempt to run rapids during low flows.

Because almost all of the sediment load of the Colorado River is retained by Glen Canyon Dam, some beaches have begun a process of erosion and degradation. Heavy recreational use also contributes to this erosion and degradation because beach material is gradually shifting into the river from foot traffic and the moving of large rafts.

The present minimum flows discussed in Section II.2. would be maintained. As previously mentioned, the uprating would not have a measurable impact on the magnitude or duration of minimum releases. Monthly and daily releases would continue in essentially the same pattern, with no significant effect on present recreational use.

Social and Economic Conditions

Based on 1980 U.S. Census figures, the population of Page, Arizona, was 4,907, up 341 percent from 1970. This growth resulted primarily from the construction of Navajo Powerplant and growing interest in the area's recreational opportunities. By comparison, Arizona's state population increased 53 percent to 2,718,215. In 1976, approximately 22 percent of the total employment in Page was attributed to tourism (Arizona Office of Economic Planning and Development).

Medical facilities are generally adequate but little specialized care is available. Medical air evacuation services to Phoenix and Flagstaff are available during emergencies.

The proposed project would not affect any social or economic conditions.

Floodplains and Wetlands

No significant floodplain or wetland encroachment would result from the uprating of the generating capacity of the Glen Canyon Powerplant; therefore, no action under Executive Order 11988 (Floodplain Management) or Executive Order 11990 (Protection of Wetlands) is necessary.

CHAPTER IV

CONSULTATION AND COORDINATION

Consultation

During preparation of the assessment, the following entities were consulted:

U.S. Fish and Wildlife Service
Western Area Power Administration
National Park Service
State of Arizona, Governor's Office
State of Arizona, Game and Fish Department
Western River Guides Association
Professional River Guides Association
Upper Colorado River Commission
Colorado River Energy Distributors Association

Responses to Comments

At the close of the extended comment period, a total of 338 responses had been received. Complete sets of these comments are available for public review at the following locations:

Bureau of Reclamation Offices

Commissioner's Office, 18th and C Streets NW., Washington, DC 20240

Engineering and Research Center, Public Affairs Office, Building 67, Denver Federal Center, Denver, Colorado 80225

Pacific Northwest Regional Office, 550 West Fort Street, Boise, Idaho 83724

Upper Colorado Regional Office, 125 South State Street, Salt Lake City, Utah 84147

Arizona Projects Office, 201 North Central Avenue, Suite 2200, Phoenix, Arizona 85073

Glen Canyon Dam, Visitor Center Rotunda, Page, Arizona 86040

National Park Service Offices

Western Region, Public Affairs Office, 450 Golden Gate Avenue, San Francisco, California 94102

Grand Canyon National Park, P.O. Box 129, Grand Canyon, Arizona 86023

Bureau of Land Management Offices

Outer Continental Shelf Office, 1340 West 6th Street, Los Angeles, California 90017

Of the 287 commentors opposing the action, 55 percent expressed concern that the operation of Glen Canyon Powerplant has, over the years, caused adverse impacts on the environment in the Grand Canyon. These respondents asked that alternatives to peaking power be considered and that legislation be initiated to control Glen Canyon releases in a more natural pattern. Since these recommendations do not deal with the assessment, they are not responded to here. Comments on the assessment are presented and discussed below:

COMMENT: The statement on trout growth gives a wrong impression. "High grading" by fishermen results in increased average size of fish harvested.

RESPONSE: Creel checks are subject to many biases and may not truly reflect actual trout growth rates, but if fisherman are "high grading" now they probably always did. Nevertheless, there is an abundance of evidence to support this statement, specifically a series of "Dingell-Johnson" Arizona fishery reports initiated in 1964. The 1977-78 report by Bancroft and Sylvester states,

> "During this period (1963-1972), the fishery was largely put-and-take catchable fishery. In 1972, the harvest consisted of 93 percent rainbow trout averaging 11.6 inches and 0.64 pounds. Channel catfish at an average length of 10.5 inches comprised 7 percent of the catch. Food production in the river continued to be low for several years after dam construction and plants of several invertebrates were made including freshwater shrimp (scuds), snails, leeches, caddis, damselflies, and mayflies. By 1972, freshwater shrimp were beginning to occur in stomach samples and growth and condition began to improve.
>
> "Between 1972 and 1976, no creel census data was collected. A shortage of trout during that period greatly reduced the number of catchable plants. Since large trout during that period were being taken in increasing numbers, it was decided early in 1976 that catchable plants should be eliminated on a level necessary to assess the reproduction occurring in the Lees Ferry area and any recruitment from downstream sources."

COMMENT: *Cladophora* is not ingested incidentally but is a trout food source.

RESPONSE: Although Cladophora can be found in many trout stomachs, other trout dietary and nutritional studies have not reported any significance or preference for selection of aquatic plants in a trout's diet. Also, there is no nutritional advantage for trout to select Cladophora.

This algae is continuously dislodged by fluctuating flows and water velocity. Trapped within the larger clumps are Gammarus and chironomid invertebrates which trout may be foraging for when they consume the Cladophora incidentally.

COMMENT: Indicate the effect of uprating on native fish.

RESPONSE: During the environmental review process, the U.S. Fish and Wildlife Service evaluated the Bureau's data and prepared a biological opinion in compliance with the consultation requirements of Section 7. Their opinion, received by the Bureau in a letter dated April 2, 1982, stated the uprates and rewinds would not impact on endangered species in the canyon. Uprating, in and of itself, would not effect existing native species composition.

COMMENT: The Aquatic section does not mention the mortality of juvenile trout due to stranding. The effect on them is probably worse than on spawning fish. A more representative sample should be collected before conclusions are drawn. How will fish losses be mitigated?

RESPONSE: While variation in flow may cause some losses to fingerling and juvenile fish, this has not been documented. Release changes cannot be recommended until this potential loss is better described. Trout stranding losses are not caused by low flows but by fluctuating flows (particularly in the 1,000-15,000 cfs range) combined with the spawner's reluctance to leave their redds. Since there will be no effect on flows below 14,000 cfs, the Bureau does not believe the minor flow change would increase trout stranding losses and the USFWS has concurred. Hatchery trout are a mainstay of today's fishery and any losses could be made up by supplemental stocking.

COMMENT: The Arizona Game and Fish Department requested written assurance that low flows would not be reduced to accommodate increased generation following uprating.

RESPONSE: As stated in the assessment, flows below 14,000 cfs would not be affected by the uprating.

COMMENT: The present criteria sets the minimum flow at 3,000 cfs during the river running season only. Because flows of 1,000 cfs are known to have a detrimental effect on fish, we would like the present criteria expanded to maintain a minimum flow 3,000 cfs year round.

RESPONSE: While present flow patterns are not optimum in terms of effects to the downstream environment, they do represent existing or baseline conditions. Enhancement of existing conditions would only be considered if specific data demonstrated fishery benefits from altered flow releases were cost-effective compared to the loss of power revenues.

Although flows of less than 4,000 cfs are probably the most limiting to aquatic invertebrates, there is no data to show they have an equally severe impact on invertebrate consumers such as trout. At any rate the uprating would not affect minimum releases.

The Fish and Wildlife Service, under the Fish and Wildlife Coordination Act requirements, has indicated that the project would not significantly impact the fishery; consequently, there is no need to increase minimum flows to mitigate the project.

COMMENT: Could swim-up fry of the humpback chub be lost to the mainstream or destroyed by cold water?

RESPONSE: To date, there is no information on the vulnerability of swim-up fry to "cold water." The Bureau believes fish will mature in cold water, but eggs and larval fish would suffer. Evidence of some egg reabsorption in the Colorado River humpback chubs has also been observed.

Chubs are maintaining a healthy, thriving population in the Little Colorado River but there is strong evidence that reproduction in the main Colorado River is probably not possible under present temperatures. Recent studies have shown that 16-18° C water is required for humpback chub eggs to remain viable but the main Colorado River water (at this point) rarely exceeds 12° C. Therefore, in all probability, chubs inhabiting the Colorado River were spawned in the Little Colorado River.

The U.S. Fish and Wildlife Service in their biological opinion (letter dated April 2, 1982) agreed with the Bureau concerning the impact of the proposed uprating: " . . . the proposed uprating of Glen Canyon Dam generating units and the concomitant increase in river flows will not affect listed species in and around the Colorado River." So even if losses do occur to young-of-the-year chubs from the effects of cold water, there is no threat to the continued existence of the humpback chub in the Grand Canyon.

COMMENT: What is the status of the razorback sucker, Colorado River chub, Colorado River squawfish, bonytail chub, and bluehead sucker? How will this project affect them?

RESPONSE: The razorback sucker still exists in the Colorado River and a small population was recently found near the confluence of the Paria River. Generally though, this fish is extremely rare in the Upper Colorado River Basin. Isolated populations may conceivably exist throughout the Grand Canyon but most specimens collected in recent years are extremely old - indicating successful natural reproduction by this species is very limited.

The Colorado River chub or roundtail chub has been extripated below Glen Canyon Dam but is common in the upper Colorado River drainage. Although this species existed in the Grand Canyon prior to Glen Canyon Dam, its relative abundance was never known. Whatever affect the operation of Glen Canyon Dam had on this fish has already occurred and the proposed uprating would not further jeopardize its existence.

The Colorado River squawfish has been extirpated from the lower Colorado River due to cold-water releases from Glen Canyon Dam. These releases have contributed to a dramatic reduction in reproductive success of most native fishes and this was an accepted tradeoff for development of cold-water fishery.

The bonytail chub has also been extirpated between Glen Canyon Dam and Lake Mead, and therefore would not be affected by the proposed uprating. The last record of a bonytail collection was in 1963 near Grand Falls in the Little Colorado River drainage. There is no information concerning the abundance of bonytail chubs within the Grand Canyon prior to the construction of Glen Canyon Dam. However, U.S. Fish and Wildlife researchers studying the bonytail and humpback chub in the upper basin believe the two species never achieved great numbers.

The bluehead sucker is the third most common native fish in the Grand Canyon, occurring from Lees Ferry downstream to Lake Mead. Recent studies of Grand Canyon aquatic fauna report the bluehead sucker is more common in summer and is found in relatively high numbers in high gradient, rocky bottom tributaries and reaches of the Colorado River. Population estimates for this fish are probably low due to behavioral characteristics which cause them to avoid certain sampling gear.

The present operation of Glen Canyon Dam is believed to limit spawning success of the bluehead sucker, but reproduction has been documented and young fish are frequently collected in the canyon. The changes in releases from the dam due to the proposed uprating would not further reduce or jeopardize the bluehead sucker existence.

COMMENT: Will prolonged inundation increase the precipitation of salts at the mouth of the Little Colorado River and contribute to the loss of humpback chub eggs by suffocation?

RESPONSE: Heavy perennial deposits of precipitates have historically occurred throughout the upper reaches of the Little Colorado River without adversely affecting humpback chub populations. While some losses of incubating eggs may occur from the heavy precipitates, they would be more pronounced in the upper reaches of the Little Colorado River and therefore should not affect eggs in those areas of lower precipitation such as the mouth of the Little Colorado.

COMMENT: There are no population surveys to support the statement that wildlife populations between the Dam and Lees Ferry are increasing. What effect will erosion have on terrestrial wildlife?

RESPONSE: Basic comparative evaluations of habitat values can be made without extensive wildlife inventories. For example, it is well-documented that riparian habitat in the Grand Canyon supports locally heavy and diverse wildlife populations (Carothers and Minckley, 1981). Prior to Glen Canyon Dam, very little mainstream riparian vegetation was present, but controlled releases have allowed riparian plant communities to expand, flourish, and provide new habitat.

Downstream erosion would not significantly increase as a result of increased flows. Analysis of several downstream cross-sections above Lees Ferry indicate a river-width increase of less than two feet, and since these higher releases would occur only for short periods, very little impact would occur.

COMMENT: There is a large difference in inundation at high and low flows. Describe the effect on beach and bank erosion with the greater daily variations.

RESPONSE: While it is true that clear water releases and increased flow variations increase the rate of beach erosion, aerial photographs taken of 27,000 cfs and 37,000 cfs releases from Glen Canyon Dam showed very little increased inundation at higher flows.

As noted in Figure 3 of the environmental assessment, it is estimated that Glen Canyon Dam discharges would only exceed present maximums 2 percent of the time. Also, Figures 10 and 11 of the assessment show that past high releases normally occur over relatively short periods of time and were greatly attenuated at Lees Ferry gauge. This present pattern is expected to continue in the future.

COMMENT: Document the need for power.

RESPONSE: See Section I. under Need for Additional Peaking Capacity.

COMMENT: What percent of time would the plant be peaked?

RESPONSE: See Section II. under Operation with Uprating and Probability of Use.

COMMENT: Explain how the Bureau would lose its capability to regulate the river and control spills if this plan is not implemented.

RESPONSE: The Bureau would not lose its capability to regulate the river and control spills if the uprating does not take place. Uprating would provide the ability to release higher levels of discharge at higher reservoir elevations which would help prevent spilling water. Without the uprating there is a higher risk of spilling when operating at higher reservoir elevations.

COMMENT: Explain how drought conditions affect minimum releases. Describe the drought operation plan and its impact downstream.

RESPONSE: Winter releases are scheduled assuming average runoff conditions for the following spring. Between January 1 and August 1, the National Weather Service provides runoff forecasts that allow the Bureau to reschedule releases as the water year progresses based on the magnitude of expected runoff.

As low runoff conditions become apparent (usually around February 1), adjustments must be made to compensate for water already released during October, November, and December. These adjustments are made in the period March through June in order to release adequate amounts of water to meet the higher power loads during the months of July and August. In below average and drought conditions, every effort is made to meet the 3,000 cfs recreation season minimum, but power contracts, laws, treaties, and compacts take precedence. This policy will continue in the future.

COMMENT: Why weren't the turbines and generators built to the same capacity originally?

RESPONSE: Turbine design is based upon the amount of change that may occur in the reservoir water surface elevations. Turbine capacity increases as the head (difference in elevation between the water surfaces in the reservoir and tailrace) increases from minimum to maximum. Generators are designed and rated at a head within the range of the turbines. Control of flow through the turbines is obtained by wicket gates, which are adjustable according to the head and demand for power. Design of the generators is based upon weighted average head, flow, and economics, and considers such factors as value and demand for power (marketing) and flexibility of the system. Hence, the design criteria for generators are more restrictive (relative to the turbines) and resulted in a rated capacity lower than the capability of the turbines. Given present economic conditions, the design studies for the generators would result in a rated capacity somewhat greater than that in the original studies; probably equal to the uprated capacity being considered today.

COMMENT: Explain the values for Figure 2.

RESPONSE: Figure 2 has been changed to Figure 4 in the final environmental assessment. This figure shows the future probability of Lake Powell reservoir elevations through year 2040. The data boundary line represents the statistical lower limit of reservoir elevation and the probability lines show the probability of the end of water year elevation being between a certain probability line and the data boundary for any given year. For example, at the end of water year 2000, there is a 25 percent probability that Lake Powell's elevation would be between 3620 feet and 3655 feet and a 75 percent probability that it would be between 3655 feet and 3700 feet.

COMMENT: The proposed higher peaks would reduce or hold back the minimums for a longer period of time. How does the Bureau intend to prevent increased impacts to the river-running industry, i.e., scheduling problems, delays, crowds at the heads of rapids, equipment damage, personal injuries, and revenue losses.

RESPONSE: As stated in Section II. under Operation with Uprating and III. under Recreation of the assessment the proposed higher peaks would not change the magnitude or duration of minimum releases.

COMMENT: Why can the Bureau not maintain higher summer minimum flows and limit peak activities to protect wildlife, habitat, and recreation values?

RESPONSE: See Chapter III. under Recreation. Maintaining higher minimum flows or limiting peak flows during the recreation season would reduce the amount of water available for release during "on-peak" hours and would be costly in terms of power revenue losses. Such flow modifications could occur only if some method of compensation for these losses is developed. This compensation could take the form of direct contributions by the recreation users, a further increase in the power rate, some combination of the two, or special legislation.

COMMENT: The dampening effect is extremely volatile. Discuss how extended low flows may actually decrease due to bank storage and evaporation as they travel through the canyon.

RESPONSE: See Section III. under River Environment and River Mechanics. Evaporation from the river is negligible.

COMMENT: Discuss the frequency of daytime flows of less than 5,000 cfs and over 28,000 cfs between Lees Ferry and Diamond Creek. How would proposed fluctuations impact wetted perimeter, beaches, and recreation between Glen Canyon and Grand Canyon?

RESPONSE: There are no hourly flow records for points between Lees Ferry and Diamond Creek other than the USGS gauge near Phantom Ranch. The USGS gauging stations at Lees Ferry and Phantom Ranch indicate that flows of less than 5,000 cfs occur between Lees Ferry and Diamond Creek primarily during the nonrecreation season when the releases at the dam are at or above 1,000 cfs. Flows of less than 5,000 cfs sometimes occur in the Grand Canyon during the recreation season after prolonged periods of low releases such as weekends. Flows exceeding 28,000 cfs are uncommon below Lees Ferry and are usually caused by flooding from tributaries. The dampening of fluctuating flows is discussed in Section III.B. and would result in negligible impacts on wetted perimeter, beaches, wildlife, and recreation.

COMMENT: Describe the effects of altered flow curves on boaters, campers, and juvenile/spawning fish. Show increases in flow patterns in addition to the pre- and post-uprating flows.

RESPONSE: There are far too many variables associated with Glen Canyon release patterns to prepare a description that would be totally representative or meaningful. While there are some seasonal patterns of releases, they are affected by such factors as power system conditions (plants and transmission facilities), unpredicted demand for power, and unseasonable weather. Releases are also tempered as water travels downstream, which further complicates the preparation of a truly representative flow pattern. See Section III.

COMMENT: Figure 3 - If higher maximum releases are to be compensated for by lowering mid-range releases, discuss the effect of these considerably larger daily variations.

RESPONSE: The higher maximum releases and the lower mid-range releases would probably not occur on the same days. When power demand is high during the peak hours of a given day, it is also usually relatively higher during non-peak hours of that same day than on days when peak demand is not so high. This tends to keep the range of fluctuation comparable. In any case, impacts from larger daily variations would be negligible below Lees Ferry due to the dampening effect of the river. Section III. under River Environment and River Mechanics discusses this effect.

COMMENT: Explain how releases of 31,571 cfs occurred at elevation 3629.

RESPONSE: The level of discharge (cfs) used to derive this figure was determined from generation tables which were developed by calibrating with river gauge readings below the dam. The latest generator index test for Glen Canyon powerplant (used in the assessment) indicates that a maximum discharge of about 31,120 cfs would result from that amount of generation at that elevation. In either case, the 31,571 cfs figure is within 1.5 percent of the above recomputed discharge and the deviation is not considered significant when compared to the $\pm$ 5 percent accuracy of the river gauge.

COMMENT: Consider the alternative and improvement of redesigning the turbine runners to achieve increased capability.

RESPONSE: Replacing turbine runners can sometimes result in greater output by improving the utilization of falling water for turbines built prior to 1960. At Glen Canyon, however, there is no economic incentive to replace or modify the turbines since the present turbine capacity exceeds the proposed uprated generator's capability. Also, because Glen Canyon turbines were installed after 1960 and are 88 percent efficient at full output, no significant improvement in energy is possible by turbine runner modification or replacement.

COMMENT: Consider the alternatives of a reregulation dam, the coal-fired plants already in the area (existing and proposed), load management, improved transmission facilities, alternative hydroelectric sites, cogeneration facilities, alternative energy sources, and no action.

RESPONSE: A reregulating dam would provide tremendous opportunity for controlling flows through the Grand Canyon but was not a viable alternative because of its higher cost and lack of support by the environmental and recreation community. Coal-fired plants serve or will serve base load needs. They are not designed for peaking duty and are not cost competitive compared to hydropeaking capacity as a result of uprating.

Load management has as its primary goal the reduction of peak loading, which in turn can reduce the amount of electric system generating capacity required. Industry has long been billed on demand, and has therefore had greater incentive to reduce demand than residential customers who are billed on energy use only. Nevertheless, modern electronic and computer technology is enabling industry to more effectively reduce peaks by staging heating, ventilating and air-conditioning loads, and other types of intermittent loads. Reduction of residential demand has to date involved a high investment for a relatively small

return. Therefore, residential customers have mainly been induced to save energy through rate restructuring, which may also reduce peak demand to some extent. Also, in some cases separate meters have been installed for water heating with timers for heating during off-peak hours at reduced rates. Such measures as remote switching of air-conditioner loads by the utilities have been experimented with. However, it is not known how such comfort reducing measures will be accepted by the public.

Improving or upgrading transmission facilities would require increasing the capacity of the overall CRSP system and any amount of capacity gained or saved by this action would be much more expensive than the capacity obtained by uprating the generators.

Alternative hydrosites are also many times more expensive than uprating. The Bureau is presently preparing proposals to uprate both Flaming Gorge and Blue Mesa hydro units, but the potential at those plants is only 18 MW and 24 MW respectively.

Cogeneration is the use of a generation facility to simultaneously produce two forms of useful energy, i.e., electric power and process steam. There is considerable interest by industry in this type of facility, but most CRSP generation and service is primarily for irrigation or municipal and farm use and therefore could not effectively utilize cogeneration.

There are other alternative energy sources in various stages of study, planning, or commercial development. These range from the burning of wood waste to such advanced technologies as nuclear fusion and solar power from space platforms. Some of these alternatives, such as certain geothermal plants and plants burning wood waste, are technically and economically feasible today. Others are in such early stages of study that no accurate estimate can be made as to their commercialization. In the CRSP marketing area, Utah Power and Light Company is planning to install a 20 MW geothermal plant is west-central Utah. The Public Service Company of New Mexico and the Imperial Irrigation District have also proposed geothermal plants. The Bureau of Reclamation initiated construction of two experimental wind turbine units in south central Wyoming. Although wind energy is commercially available, it is not, by itself, a reliable source of energy and its utilization is uncertain. In summary, the above alternative sources of energy would be used to complement existing power sources not replace them. The "No Action" alternative is discussed in Section II.

COMMENT: Explain the impact on energy output if an uprated generator goes down.

RESPONSE: The loss of an uprated generator would be no different than losing an existing generator owing to system reserve requirements of the CRSP Inland Power Pool. If an uprated generator were producing peak output at the time of outage, the loss of generation would be greater than with present operations. With the flexibility afforded by uprating, however, the remaining seven generators would have enough capacity to nearly equal the generation of the inoperative unit.

COMMENT: Define "emergency situation."

RESPONSE: An emergency situation as used in the context of the assessment is the occurrence of conditions such as partial loss of plant generation or trouble in the power system that requires additional generation from another source to assure delivery of power to the consumer.

COMMENT: Alternatives such as rate restructure, alternate sources of capacity, operating economies, conservation and negotiated contracts were not properly costed out. Use the prescribed formulas to determine proper alternatives, benefits, and costs to produce energy.

RESPONSE: Nonstructural alternatives have been discussed in various publications available to the public (EPRI Journals). These reports indicate various methods under consideration and determined costs and benefits. Nonstructural alternatives were considered for this study, but were not considered viable because the cost estimates per kilowatt as documented in these publications are higher than the per kilowatt costs estimated for the Glen Canyon uprates.

The assessment used the prescribed procedures (the least cost/most likely alternative) to determine the costs and benefits associated with this analysis.

The most likely alternative to the Glen Canyon uprating is the combustion turbine because of its lower cost. Because benefits are based on the savings of not implementing the alternative, the lower the alternative cost the lower the benefit and vice versa.

COMMENT: Discuss the timing and assumptions of energy return and its impact on recreation.

RESPONSE: Timing and assumptions of energy return refers to marketing of peaking power and is described in Attachment A, "General Power Marketing Criteria." In summary, while power customers will contract for incremental capacity for anticipated peak demand, additional energy is not actually purchased until generation occurs. It is assumed that customers purchasing peaking power will not have the capacity to return the energy during the same period, but that it will be returned at some mutually convenient time during the contract period. Because of the need to maintain stream flows during off-peak periods, and contractual penalties for off-peak hour returns, energy is usually returned during average use periods. Consequently, more energy is returned to the system at on-peak times during off-peak months (March-June, September-November).

This pattern has the effect of slightly reducing mid-range flows but has no impact on flows below 14,000 cfs. This would have no significant impact on recreation.

COMMENT: Your cover letter states that uprating is in no way associated with the peaking power issue, but the draft environmental assessment on page 11 states that the result of uprating will be peaking power for sale thus, the issue is peaking power.

RESPONSE: The cover letter stated that the uprating is not associated with the "Glen Canyon Peaking Power Study" which was terminated in October 1981. That study considered adding two new units in a separate powerplant at Glen Canyon Dam and increasing maximum flows to 40,000 cfs. The Glen Canyon Powerplant was always intended to be used to generate peaking power.

COMMENT: How often is the increased capacity expected to be used?

RESPONSE: While the increased capacity may be fully sold, actual generation at an increased level is dependent upon power system conditions. Assuming that Lake Powell elevations are high enough, utilization of some of the uprated capacity is expected to occur about 7 percent of the time.

COMMENT: If Figure 1 is correct, uprating will raise the maximum power outflow from 27,000 cfs to 33,100 cfs, a much more significant increase of 6,100 cfs than the 1,600 cfs the text asks us to accept.

RESPONSE: Figure 1 has been changed to Figure 3 in the final assessment. Data from the curves shown on Figure 3 have been summarized in Tables 2 and 3 and are described in Section II.B.2.

COMMENT: The assessment indicates that the "insignificant" impact of 1,600 cfs will cause little or no discernable rise in water level; however, it can only worsen an already bad situation since water will be "made up" for peak hours by lowering minimum flows.

RESPONSE: As shown on Figure 2, uprating would not affect minimum flows. Only flows above 14,000 cfs would change. The figure also shows peak flows utilizing the 1,600 cfs increase would occur less than 2 percent of the time. This increase would attenuate significantly between the dam and Lees Ferry. (See Section III. under River Environment and River Mechanics.)

COMMENT: The average rates are not as important as specific high and low flows and neither is the magnitude of the rate change in flow.

RESPONSE: The specific high and low discharges at the dam are previously stated. (See Section II. under Release Patterns and III. under River Environment and River Mechanics.)

COMMENT: Minimum releases of 3,000 cfs and 1,000 cfs are supposedly absolute and unaffected by uprating, yet flows of 10-25 percent lower have occurred. The additional water released with increased capacity may cause lower flows or shorter durations of higher releases and these impacts to recreation and beach erosion should be considered.

RESPONSE: Section II. under Release Patterns describes the minimum flow guidelines. The flow duration curves shown on Figure 2 show that the higher releases would occur about 7 percent of the time and that the occurrence of releases would be reduced in the 14,000 to 24,000 cfs range. As stated in the environmental assessment, the uprating would not affect the magnitude or duration of minimum flows. The assessment also considers the potential impact to recreation and beach erosion and states that these effects would be negligible.

COMMENT: Marketing: Explain this sentence: "Load diversity among WAPA customers more than offset(s) all capacity losses associated with transmission and delivery."

RESPONSE: System load diversity results from individual customers not having their peak electrical usage occur simultaneously for various reasons. These are differences in customer living habits and use patterns, time zone changes which stagger peak use times, and other factors such as variations in load types and demand types (municipal versus irrigation). The exact reasons for diversity are not easily definable.

For example, assume a system has three customers with peak loads between 9 a.m. and noon of 100 kW, 200 kW, and 300 kW, for a total of 600 kW. Although each customer contracts for a given amount of power, the total amount is not necessarily used. So if the system peaks at 540 kW for that time period (or 60 kW less than the amount contracted for) the diveristy is 10 percent (600 kW ÷ 60 kW unused = 10 percent).

In any power system, generation must exceed the contracted load by the amount of losses within the power system. However, if there is system diversity, the amount of generation can be reduced by the percent of diversity. In the CRSP system, diversity is estimated to exceed losses, so losses are cancelled. Therefore, the sum of the individual customer loads equals the generation required.

COMMENT: Discuss the characteristics of present power production and WAPA changes under the alternatives. How much and what kind of capacity and/or energy are now and would be available under each alternative, in what markets are they used, and what is the significance of their availability? The present "marketing" section attempts this, but only describes criteria, and does not analyze significance of the resource.

RESPONSE: CRSP power, including that from Glen Canyon generation, is presently marketed in the amounts shown in Part 5 of the "General Power Marketing Criteria" (Attachment A). In both the summer and winter seasons that portion called "long-term firm power" is marketed at 58.2 percent load factor, or in other words, the capacity is available 2,550 hours per season. The remainder (excluding project use) is allocated to peaking and reserves. If sufficient water is not available to supply firm energy at 58.2 percent power factor, energy must be purchased to make up the deficiency. The peaking power is supplied without energy. This means that the energy associated with the peak power sale must be returned by the receiving entity at some future time.

Based upon historical water releases at Glen Canyon for the 1970-1981 period, the plant was capable of generating an average of 3,940 million kilowatt-hours per year at lake elevation 3641 feet. Based upon the present 1,150 MW peak capacity that amount of energy would result in a 39 percent load factor. Increasing the peak capacity by uprating while not increasing the amount of energy generation will result in a reduced load factor on the Glen Canyon Powerplant. At the full anticipated uprate capacity of 1,336 MW the load factor for the 1970-1981 period would have been reduced to 33.6 percent.

The additional uprate capacity would be sold without energy to qualifying CRSP customers throughout the market area. Due to the uprate capacity not being available every year, Western personnel have indicated they would most likely market this peaking power on a short-term basis, probably annually.

Using the uprate capacity only for emergencies or maintenance would not result in increased peak sales, but would allow greater flexibility in scheduling maintenance without interfering with firm power sales. The total uprate capacity is anticipated to be 186 MW, which exceeds the 167 MW of capacity lost when a unit is out of service for maintenance.

CHAPTER V

BIBLIOGRAPHY

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ATTACHMENT A

DEPARTMENT OF ENERGY

FEB 9 1978

Western Area Power Administration
COLORADO RIVER STORAGE PROJECT
General Power Marketing Criteria

1. General.—These criteria are based upon the provisions of the Act of Congress approved June 17, 1902 (32 Stat. 388), the Act of Congress approved August 4, 1939 (53 Stat. 1187), the Act of Congress approved April 11, 1956 (70 Stat. 105), the Act of Congress approved August 4, 1977 (91 Stat. 565), and acts amendatory or supplementary to the foregoing acts, and shall become effective upon approval and promulgation by the Secretary of the Department of Energy (DOE), but existing contract arrangements will only be affected upon amendment by the parties. These criteria shall supersede and replace the "General Power Marketing Criteria" for sale of power from CRSP approved March 1962 and continue to be subject to change upon reasonable notice by the Secretary of DOE and the opportunity for comment by interested parties.

2. Market Area.—The market area within which the power from CRSP shall be marketed is divided into two divisions:

A. The Northern Division, which consists of the States of Colorado, New Mexico, Utah, Wyoming, the town of Page, Arizona, a portion of the area in Arizona to be served by the Navajo Tribal Utility Authority, and White Pine County and portions of Elko and Eureka Counties in Nevada.

B. The Southern Division, which consists of the remaining portion of the State of Arizona, that part of the State of Nevada in Clark, Lincoln, and Nye Counties which comprise the southern portion of the State, and that part of the State of California east of the 115th degree of longtitude, or, generally, the area contiguous to the Colorado River.

3. Service Seasons.—

A. Summer Season. The 6-month period from the first day of the April billing period through the last day of the September billing period in any calendar year.

B. Winter Season. The 6-month period from the first day of the October billing period of any calendar year through the last day of the March billing period of the next succeeding calendar year.

The establishment of service seasons does not preclude the furnishing of supplemental monthly requirements to CRSP customers in any month.

4. Power Marketing.—All classes of CRSP power available for marketing shall be stated herein and those entities statutorily entitled to preference will be given preference in the sale of all CRSP power and/or energy. All sales of CRSP power and/or energy to a nonpreference customer for a term longer than one season shall be subject to recapture for the use or benefit of CRSP and its preference customers.

A. Long-Term Firm Power (Capacity with Energy).—Long-term firm seasonal capacity available shall be as stated in section 5, and associated energy available therewith will depend upon long-term hydrological conditions on the Colorado River. The greatest practicable amount of available energy that can be sold at firm energy rates will be associated with firm power and made available to contractors on an equitable basis.

B. Short-Term Firm Power (Capacity with Energy).—To the extent that priority uses as indicated in section 5 do not develop as rapidly as contemplated and/or annual system streamflow conditions exceed those on which the amounts of firm power in section 5 are based, short-term firm power will normally be offered for sale on a season-by-season or monthly basis. Energy availability will depend upon short-term hydrological conditions on the Colorado River and availability of energy from other Reclamation projects. The greatest practicable amount of available energy that can be sold at firm energy rates will be associated with firm power, including short-term firm power, and made available to contractors on an equitable basis.

C. Long-Term Peaking Power (Capacity without Energy).—Long-term peaking capacity available shall be as stated in section 5 and will be offered first to preference customers having long-term firm power contract commitments.

D. Short-Term Peaking Power (Capacity without Energy).—To the extent that priority uses as indicated in section 5 do not develop as rapidly as contemplated and/or annual system streamflow conditons exceed those on which the amounts of peaking power in section 5 are based, short-term peaking power without energy will normally be offered for sale on a season-by-season or monthly basis.

E. Other Power.—In addition to marketing the above classes of power, CRSP will engage in normal transactions such as delivering or receiving interchange, emergency, or maintenance services to the extent hydrological conditions permit. In order to conserve fossil fuel, enhance the environment, and ensure the availability to preference customers of contracted amounts of CRSP power and energy, CRSP will purchase or exchange capacity and energy as necessary or desirable to supplement its resources. Interruptible fossil-fuel replacement energy service may be available as a result of these purchases or exchanges.

5. Power Available for Load.—The minimum capacity available from the project for long-term marketing at the designated points of delivery listed in section 9 shall be 1,324 MW after the addition of the Crystal Dam and Powerplant. Through the 1989 summer season, this capacity will be distributed among the following classes of service:

Capacity (MW)

Purpose	Summer	Winter
Federal project priority uses...	55	6
Long-term firm..................	1,161	1,041
Long-term peaking...............	108	277
Total.....................	1,324	1,324

To the extent the amount available for Federal project priority uses is not required for such uses, it shall be made available to preference customers as short-term firm power, and Northern Division customers shall be given first right to contract therefor. The amounts shown for priority uses are those required to serve CRSP and participating projects' pumping and desalting loads which are expected to develop by 1985 and to firm up Rio Grande Project generation during the summer seasons. The quantities shown will be reexamined prior to expiration of existing contracts and may be modified to adapt to conditions as they exist.

6. Allotment of Firm Power and Peaking Power.—

A. Firm Power.—

(1) Southern Division. In April 1963, preference customers in the Southern Division were allotted firm power amounting to 240 MW in the summer season and 84 MW in the winter season, and the allocation was updated in September 1975.

(2) Northern Division. The remaining available firm power was allotted to Northern Division preference customers and amounted to 922 MW in the summer season and 957 MW in the winter season.

B. Peaking Power.—

(1) Southern Division. Based on the Southern Division's entitlement of 20 percent of net capacity available for load in the summer and 7 percent in the winter, as provided in the "General Power Marketing Criteria" approved in March 1962 and reaffirmed by these criteria, Southern Division preference customers have been allocated 24,800 kW and 8,700 kW of peaking power, without energy, in the summer and winter seasons, respectively.

These figures for the Southern Division were determined as follows:

	Summer MW	Winter MW
Total entitlement...............	1/	2/
Less firm power entitlement.....	240.0	84.0
Peaking power entitlement.............	24.8	8.7

1/ (0.2 x 1,324)=264.8
2/ (0.07 x 1,324)=92.7

(2) Northern Division. Northern Division preference customers have been allocated the remainder of the presently proposed allocation of peaking power.

C. Sale of Peaking Power Not Contracted for by Preference Customers.—Any amounts of peaking power allotment offered to and not accepted by existing firm power preference customers shall be reallocated among those preference customers requesting peaking power. Any amount not contracted for by existing preference customers will be offered for sale to others.

7. Firm Capacity and Energy Obligations.—The Western Area Power Administration (WAPA), in cooperation with the preference customers, will establish mutually agreeable scheduling and accounting practices based upon standard utility industry procedures which will provide efficient practicable utilization of CRSP power and energy, including peaking capacity. These shall be set forth in the CRSP contracts or in separate written agreements made a part thereof. CRSP capacity and energy obligations shall be based on amounts established pursuant to these scheduling and accounting procedures.

A. Scheduling.—

(1) By Mutual Agreement.—

(a) A preseason schedule of the customer's CRSP power and energy requirements (entitlements) by billing period shall be developed at least 60 days prior to the beginning of each season.

(b) Departures from the preseason schedule will be permitted to accommodate changes in customers' seasonal peakloads.

(c) Daily CRSP capacity and energy deliveries shall be scheduled to best satisfy the loads for which they are intended, consistent with the resources available.

(2) In the event of failure to reach mutual agreement, and in order to allow CRSP to schedule major maintenance outages for its plants and to comply with required water releases, treaties, and other requirements, CRSP shall establish schedules of capacity and energy deliveries within the following limitations:

(a) The maximum rate of delivery for CRSP firm and peaking power in each billing period shall be scheduled to follow approximately the customer's system load pattern during each season by months with the full contract rate of delivery for CRSP firm and peaking power being available for the customer's seasonal peakload month(s). The customer shall be obligated to furnish the auxiliary power required to meet its power requirements in excess of the amounts of power scheduled to be furnished by the CRSP.

(b) The minimum scheduled rate of delivery for CRSP firm power shall be the least of:

(i) The customer's proportionate share of projected minimum load requirements on the CRSP system; or

(ii) Thirty-five percent of the customer's firm-power rate of delivery; or

(iii) The customer's total load.

(3) The CRSP firm energy obligation shall be 2,550 kilowatt-hours per kilowatt of contract rate of delivery

for CRSP firm power per season for the terms of existing power sales contracts.

This established limit may be increased from time to time at CRSP's discretion should short-term conditions allow. In the event that during the terms of existing contracts the established limit shall be increased for any season, it may be decreased in future seasons; but in no event shall it be decreased below 2,550 kWh per kW. The established limit for the season shall be scheduled in each billing period to follow approximately the customer's system energy pattern during each season by months.

B. Accounting.—The amounts of CRSP power and/or energy to be paid for by the customer shall be determined in accordance with the accounting procedures set forth in the CRSP contracts, or in separate written agreements made a part thereof, and need not be the amounts scheduled pursuant to "A" above. Any deviation between the quantity of energy scheduled and that delivered in a billing period shall be accounted for by increasing or decreasing the entitlement of CRSP energy available to the customer in subsequent months of the current season as agreed by the customer and CRSP. Said accounting procedures shall include procedures for determining amounts of CRSP power and energy delivered to the customer at each point of delivery or point of use.

In order to assure the availability of the amounts of firm power and energy contracted for, WAPA will purchase or exchange capacity and/or energy as necessary to meet contract commitments.

8. Contractual Arrangements.—

A. Long-Term Firm Power (Capacity with Energy).—Subject to the provisions of section 8.D. of these criteria, contracts for long-term firm power will be for periods of 20 years unless otherwise mutually agreed.

B. Short-Term Firm Power (Capacity with Energy).—As water conditions permit, short-term firm power will be offered on a season-by-season or monthly basis.

C. Peaking Power (Capacity without Energy).—For existing customers with long-term firm power contracts, peaking power will be sold for the term of the existing contracts. Any amount not contracted for by existing preference customers will be offered first to other preference customers and then to others for periods not to exceed 10 years subject to recapture on not more than 5 years' notice.

D. Expiration of Contracts.—Long-term firm contract commitments expiring before 1989 shall be extended to the end of the September 1989 billing period so that all CRSP long-term firm power and/or long-term peaking power commitments expire concurrently. Joint discussions between WAPA and preference customers for extension or renewal of CRSP contracts shall begin by January 1, 1979.

In recognition of the leadtime required to place major generation projects in operation, WAPA will provide a minimum of 5 years' notice should it propose to reduce, upon expiraation of a firm power contract between WAPA and a customer, the amount of firm power or long-term peaking power allocated to the customer or substantially change the amount of energy available to the customer under the customer's firm power allocation.

Unless otherwise agreed, drafts of contracts or supplements to existing contracts proposed by WAPA or the customer shall be submitted for review and comment at least one hundred and twenty (120) calendar days prior to the execution deadline of the contract or supplement.

9. Delivery Conditions.—Subject to WAPA approval as to location and voltage, normal delivery will be made at CRSP transmission system voltages or at the customer's transmission voltage, but not less than 115 kilovolts. Delivery will continue to be made at lower voltages at powerplant and substation locations where customers already have systems operating at such lower voltage levels.

Designated or Equivalent Federal Points of Delivery will be at:

(A) Points on the CRSP transmission system; or

(B) Points on the system of a non-Federal entity which have been established as delivery points under arrangements between WAPA and that entity.

If such arrangements are terminated, then the delivery points under (B) above will be rescinded. These points are listed below and may be modified as hereinafter provided.

DESIGNATED OR EQUIVALENT FEDERAL POINTS
OF DELIVERY, TAP POINTS, AND VOLTAGES

Arizona	Kilovolt
Glen Canyon......................	69
Mesa.............................	230
Pinnacle Peak[1/]..................	230

Montana

Yellowtail 2/ 230

1/ Deliveries to Nevada customers made from Pinnacle Peak.
2/ Points of delivery on system of non-Federal entity.

The listing of the above Points of Delivery does not imply any obligation for CRSP to furnish additional facilities at those points. Additional delivery points requested by the customers and approved by WAPA will be permitted provided that they meet the above criteria and will not result in any expense or loss of revenue to CRSP. Delivery will not be made from transformer capacity required for CRSP purposes. Taps on the CRSP or other transmission system, at the customer's expense, will be on a case-by-case basis with final determination of necessity and desirability to be made by CRSP and/or the owner of such transmission system.

Additional delivery points on the systems of other Federal projects may be considered if wheeling charges are promulgated by the Secretary of Energy as provided in section 10.D. hereof.

10. Delivery of Power Beyond Delivery Points.--All costs, including losses, for delivery of power and energy beyond the delivery points specified in section 9 hereof shall be borne by the customer. Instances where additional transmission line capacity is required to effect delivery beyond CRSP delivery points will be considered as individual cases to be justified on their own merits. WAPA participation in joint ownership of facilities will be avoided in any plans for providing the additional transmission line facilities. The following alternatives are available to customers for accomplishing delivery of CRSP power beyond the CRSP system delivery points shown in the table in section 9 hereof:

A. The customer or customers may build all facilities to accept delivery at the established voltage at identified CRSP delivery points, in which case the customer will pay the standard CRSP rates for power.

B. Arrangements may be made with a third party to wheel and deliver power to a customer's point of use. Such arrangements may be made by WAPA, by the customer, or by a group of customers. If WAPA makes the wheeling arrangements, WAPA will add a surcharge to the customer's billing to recover the costs thereof. If the customer makes its own wheeling arrangements, the customer will pay the wheeling charges directly to the wheeling agent.

C. WAPA may construct the transmission line facilities required beyond the identified CRSP delivery points, in which case a surcharge above the rate for CRSP power at the identified delivery points on the CRSP system will be applied to recover from the beneficiaries thereof the costs of facilities constructed by WAPA beyond such delivery points.

D. WAPA will transmit CRSP power to customers over existing transmission systems of other projects to the extent that capacity is determined to be available. Capacity in these other project transmission systems to the extent possible will be available for the term of the CRSP contracts involved. No additional charges will be imposed unless additional substation or switching station capacity is required or where utilization of another project's system would delay project repayment beyond the point in time which would otherwise be the case. At some future date, the Secretary may charge for transmission service for delivery of CRSP power over other Federal systems such as the Parker-Davis and Pick-Sloan Missouri Basin Projects. The customer will pay for such service at a rate determined by the Secretary which may be assessed as early as 1978 but shall not be later than the termination date of the customer's existing power sales contracts as they may be amended, or in any event, by October 1, 1989.

Colorado	Kilovolt
Ault	230
Beaver Creek[2/]	115
North Main Tap (Gunnison)	115
Gore Pass Tap	138
Green Mountain	115
Gunnison	115, 12.5
Hayden	138
Midway	230, 115
Montrose	115
Pueblo[2/]	115
Rangely	138
Salida (Poncha Junction)	115
Skito Tap	115
Story[2/]	230
Weld	230, 115

New Mexico	
Albuquerque[2/]	115
Ambrosia Lake[2/]	115
Shiprock	230, 115

Utah	
Brigham City Tap[2/]	138
Bountiful Tap[2/]	138
Centerfield[2/]	138
Fillmore[2/]	138
Flaming Gorge	69, 24.9
Hale Plant Tap[2/]	138
Hyrum[2/]	138
Murray Tap[2/]	138
New Castle Tap[2/]	138
Paragonah[2/]	138
Sigurd[2/]	138
Smithfield Tap[2/]	138
South Provo Tap[2/]	138
Springville[2/]	138
St. George[2/]	138
Vernal	138
Upalco Tap[2/]	138
Henrieville Tap[2/]	230

Wyoming	
Archer	230, 115
Casper[2/]	115
Glenrock[2/]	230, 115
Thermopolis	115

Prepared 11/9/81

ATTACHMENT B

MAXIMUM RELEASE OF WATER FROM GLEN CANYON DAM
FOR EACH MONTH FROM SEPT 1964 TO SEPT 1981
AND EACH DAY RELEASE EXCEEDED 28,000 c.f.s.

Date		c.f.s.	Lake Elevation
1964	Sept 2	7,150	
	Oct 16	5,900	
	Nov 16	6,200	
	*Dec 30	13,500	3491.94
1965	Jan 27	9,300	
	Feb 12	15,100	
	Mar 17	27,175	
	April 10	30,375	
	11	28,400	
	22	30,980	
	23	37,775	
	24	35,875	
	25	35,350	
	26	45,330	
	27	42,660	
	28	36,175	
	29	35,825	
	30	32,450	
	May 3	45,605	
	4	50,905	
	5	40,200	
	6	40,225	
	7	47,400	
	8	47,650	
	9	39,375	
	10	36,550	
	11	36,325	
	12	32,000	
	16	51,925	
	17	32,180	
	18	29,105	
	20	37,325	
	21	41,325	
	22	42,615	
	23	53,275	
	24	54,975	
	25	54,675	
	26	54,850	
	27	54,650	
	28	54,350	
	29	52,205	
	30	51,880	
	31	42,643	

Date		c.f.s.	Lake Elevation
1965	June 1	41,243	
	2	38,315	
	3	38,365	
	4	38,215	
	5	40,425	
	6	48,505	
	7	48,405	
	8	43,435	
	9	41,100	
	10	40,875	
	11	48,055	
	12	55,415	
	13	55,365	
	14	55,290	
	*15	55,735	3492.81
	16	35,255	
	17	35,469	
	18	45,165	
	19	45,250	
	20	45,190	
	21	45,540	
	22	46,060	
	23	46,110	
	24	45,960	
	25	45,440	
	26	30,390	
	July 31	16,900	
	Aug 5	16,850	
	Sept 11	16,950	
	Oct 21	19,450	
	Nov 4	17,900	
	Dec 28	18,700	
1966	Jan 26	20,750	
	Feb 16	19,750	
	Mar 17	19,650	
	Apr 27	20,582	
	*May 18	20,900	3543.47
	June 2	20,423	
	July 13	18,836	
	Aug 17	17,725	
	Sept 24	18,836	
	Oct 31	18,420	
	Nov 10	20,215	
	Dec 22	16,920	

*High water release for the year

Date		c.f.s.	Lake Elevation
1967	Jan 3	19,110	
	Feb 15	15,600	
	Mar 9	18,450	
	*Apr 19	24,400	3509.10
	May 11	21,530	
	June24	21,005	
	July 6	18,835	
	Aug 8	17,400	
	Sept 7	17,575	
	Oct 31	15,200	
	Nov 22	19,400	
	Dec 15	20,690	
1968	Jan 22	21,950	
	Feb 9	19,150	
	Mar 29	24,840	
	*Apr 14	26,960	3516.63
	May 7	26,600	
	June20	25,840	
	July19	26,360	
	Aug 28	24,800	
	Sept11	21,670	
	Oct 17	19,395	
	Nov 20	19,605	
	Dec 19	21,250	
1969	Jan 24	20,970	
	Feb 1	23,000	
	Mar 14	23,320	
	Apr 21	24,720	
	*May 14	26,800	3559.57
	June 6	26,600	
	July 1	25,200	
	Aug 11	25,280	
	Sept 8	23,200	
	Oct 30	21,635	
	Nov 13	22,160	
	Dec 4	24,800	
1970	Jan 8	23,600	
	Feb 11	21,620	
	Mar 10	19,920	
	Apr 24	27,440	
	May 20	27,280	
	Jun 25	26,840	
	*July17	27,760	3601.63
	Aug 26	26,240	
	Sept 2	27,160	
	Oct 22	18,485	
	Nov 24	20,200	
	Dec 22	26,000	

Date		c.f.s.	Lake Elevation
1971	Jan 7	24,000	
	Feb 26	21,425	
	Mar 2	21,775	
	Apr 5	29,000	
	May 24	28,600	
	May 25	28,240	
	May 26	28,400	
	Jun 18	30,000	
	Jun 25	28,600	
	Jun 28	28,160	
	July12	29,500	
	Aug 3	28,360	
	16	28,360	
	23	29,200	
	25	28,240	
	26	28,120	
	*Aug 30	31,200	3617.42
	Sept 1	29,750	
	11	28,160	
	13	28,760	
	14	29,150	
	15	28,320	
	16	28,920	
	Oct 14	22,825	
	Nov 15	27,080	
	Dec 31	26,600	
1972	Jan 31	26,400	
	Feb 1	26,560	
	Mar 8	16,340	
	Apr 14	28,960	
	May 11	29,163	
	12	29,447	
	15	29,163	
	16	28,879	
	23	30,158	
	24	29,873	
	25	30,726	
	26	29,873	
	31	29,021	
	Jun 1	30,200	
	2	32,100	
	8	29,000	
	13	29,450	
	15	30,450	
	27	38,680	
	28	28,000	
	July27	31,900	
	31	29,250	

*High water release for the year

Date		c.f.s.	Lake Elevation
1972 Continued			
	Aug 2	28,760	
	7	30,700	
	8	29,550	
	9	31,650	
	*10	32,800	3613.48
	11	29,600	
	14	31,550	
	15	30,350	
	16	28,840	
	17	29,100	
	18	30,850	
	21	31,900	
	22	30,750	
	28	29,800	
	29	30,100	
	30	28,080	
	Sept14	29,850	
	15	29,450	
	16	28,480	
	18	28,800	
	Oct 16	27,080	
	Nov 30	26,200	
	Dec 6	28,640	
	7	28,200	
	11	29,400	
	12	28,480	
	13	29,950	
	14	29,750	
	15	28,760	
	18	28,280	
	19	28,680	
	21	30,100	
	22	28,480	
	27	29,200	
	28	28,680	
	29	29,300	
	30	30,000	
1973	Jan 2	28,879	
	3	28,879	
	4	28,737	
	5	29,447	
	6	29,305	
	8	29,645	
	9	29,502	
	10	29,215	
	11	29,933	
	12	30,220	
	15	29,215	
	16	28,353	
	17	29,645	
	18	29,215	
	19	29,215	

Date		c.f.s.	Lake Elevation
1973	Jan 20	28,640	
	22	29,645	
	23	29,071	
	24	29,358	
	25	28,640	
	26	29,645	
	27	29,645	
	29	28,927	
	31	29,502	
	Feb 20	29,358	
	21	29,502	
	Mar 22	29,358	
	23	29,645	
	25	28,927	
	26	29,645	
	27	29,933	
	28	30,076	
	29	29,645	
	30	29,645	
	Apr 2	29,645	
	3	29,645	
	4	29,502	
	5	29,645	
	6	29,502	
	9	29,071	
	10	29,693	
	11	29,838	
	12	29,838	
	13	29,548	
	14	29,693	
	15	29,257	
	16	29,403	
	17	29,838	
	18	29,548	
	19	29,693	
	20	29,257	
	21	29,403	
	22	28,822	
	23	29,403	
	24	29,257	
	25	29,112	
	26	29,257	
	27	28,677	
	28	29,403	
	29	29,112	
	30	29,693	
	May 1	28,967	
	17	28,353	
	18	28,927	
	19	28,927	
	*June 5	30,817	3619.76
	6	30,256	
	7	29,414	
	8	30,536	
	11	28,853	

*High water release for the year

Date	c.f.s.	Lake Elevation
1973 Continued		
June 26	28,539	
27	29,315	
July 5	28,359	
11	28,086	
Aug 21	26,309	
Sept 5	18,734	
Oct 25	21,026	
Nov 27	24,126	
Dec 17	23,048	
1974 Jan 2	28,980	
3	29,250	
4	29,384	
5	28,710	
7	29,654	
8	29,250	
9	28,171	
10	28,306	
*11	29,924	3647.32
12	28,171	
21	29,250	
Feb 25	21,700	
Mar 28	23,452	
Apr 23	21,430	
May 13	28,242	
28	28,375	
June 17	28,036	
24	28,167	
25	28,167	
26	28,561	
27	28,692	
28	28,430	
July 1	28,167	
2	28,198	
8	28,561	
9	28,430	
10	28,298	
11	28,167	
16	28,430	
17	29,439	
18	28,774	
19	29,306	
22	29,173	
24	28,375	
25	38,508	
26	28,242	
Aug 1	28,774	
14	28,109	
20	29,040	
22	28,375	
23	28,774	

Date	c.f.s.	Lake Elevation
1974 Aug 24	29,306	
25	28,109	
26	28,375	
28	28,508	
Sept25	25,609	
Oct 30	24,531	
Nov 6	28,306	
26	28,576	
27	28,710	
Dec 16	28,036	
1975 Jan 10	28,576	
11	28,980	
12	28,845	
13	29,384	
21	28,441	
Feb 10	26,362	
Mar 27	23,992	
Apr 28	21,295	
May 7	28,845	
8	29,115	
27	28,171	
Jun 4	29,306	
5	28,109	
6	28,375	
13	28,109	
16	29,306	
23	28,167	
30	38,561	
Jul 1	28,823	
3	28,298	
5	28,167	
6	28,692	
7	28,430	
8	28,823	
9	28,954	
10	28,561	
11	28,298	
14	28,518	
17	28,518	
18	28,780	
19	28,256	
21	28,780	
22	28,387	
23	28,911	
27	28,649	
29	29,435	
31	28,515	
Aug 5	28,911	
6	28,911	
7	28,780	
8	28,649	
*9	29,566	3674.27

*High water release for the year

Date	c.f.s.	Lake Elevation
1975 Aug 10	28,387	
11	28,649	
19	28,125	
26	28,911	
29	28,387	
Sept 4	28,387	
9	28,518	
11	28,125	
Oct 6	28,780	
Nov 11	27,994	
Dec 17	28,256	
18	28,125	
20	28,256	
1976 Jan 14	28,256	
19	28,256	
Feb 10	25,767	
Mar 12	28,387	
Apr 26	24,886	
May 14	28,074	
19	29,042	
Jun 3	28,125	
7	28,518	
8	28,911	
9	28,256	
10	28,387	
29	28,125	
*Jul 6	29,304	3672.28
9	28,125	
26	28,387	
28	28,387	
Aug 30	28,387	
Sep 10	27,732	
Oct 28	25,683	
Nov 28	24,886	
Dec 30	28,340	
1977 Jan 3	28,606	
5	29,004	
6	29,221	
7	28,818	
8	28,413	
10	28,278	
11	29,356	
14	28,548	
17	29,760	
18	28,413	
19	28,009	
24	28,144	
25	28,298	
27	28,682	
29	28,682	
30	29,356	
1977 Feb 1	22,662	
Mar 2	29,221	
3	28,144	
Apr 18	17,420	
May 2	17,420	
Jun 27	29,491	
Jul 7	28,009	
8	28,413	
18	28,278	
19	29,221	
22	28,278	
25	28,413	
31	28,144	
Aug 1	29,625	
2	28,682	
3	29,087	
4	28,548	
8	28,952	
12	29,087	
13	29,491	
15	28,817	
16	30,164	
17	29,760	
18	29,760	
19	29,567	
20	28,885	
22	29,704	
23	29,294	
24	29,704	
25	30,250	
26	29,021	
Sep 1	30,114	
2	29,567	
* 6	30,933	3641.52
7	30,523	
8	30,387	
Oct 6	21,985	
Nov 21	26,727	
Dec 20	26,865	
1978*Jan 19	31,155	3626.95
20	28,664	
23	30,879	
24	30,187	
31	29,356	
Feb 1	28,425	
Mar 3	25,654	
Apr 21	22,914	
May 26	27,280	
Jun 5	28,475	
Jun 26	28,144	
Jul 10	27,066	

*High water release for the year

Date	c.f.s.	Lake Elevation
1978 Continued		
Aug 7	28,548	
8	28,009	
15	28,144	
16	28,548	
17	28,144	
21	29,087	
22	29,760	
23	29,625	
24	29,760	
25	29,087	
28	28,009	
31	29,895	
Sep 4	28,202	
5	31,069	
6	29,431	
7	29,841	
8	30,660	
10	29,294	
11	28,065	
Oct 19	26,154	
Nov 20	26,563	
Dec 18	28,387	
20	28,941	
27	28,911	
28	29,495	
29	28,941	
1979 Jan 2	28,526	
3	29,079	
4	29,356	
5	30,048	
6	28,249	
8	30,187	
9	29,910	
10	28,526	
11	28,526	
12	28,526	
15	30,602	
16	29,771	
17	30,187	
18	28,526	
19	29,910	
22	29,356	
23	28,664	
24	28,526	
25	30,048	
26	29,218	
*29	31,571	3629.37
30	29,771	
31	29,633	

Date	c.f.s.	Lake Elevation
1979 Feb 1	30,602	
2	29,079	
3	28,941	
5	29,356	
6	29,356	
7	29,771	
15	29,218	
16	28,526	
Mar 2	26,727	
Apr 9	23,061	
May 23	24,886	
Jun 13	28,515	
Jul 11	28,160	
13	28,031	
23	28,290	
27	28,548	
31	29,194	
Aug 1	29,194	
2	28,548	
4	28,548	
5	28,160	
6	28,935	
7	29,064	
8	28,677	
17	28,419	
20	28,677	
26	28,290	
28	28,677	
Sept 4	28,031	
6	28,419	
Oct 29	25,190	
Nov 1	25,319	
Dec 26	26,946	
1980 Jan 28	28,387	
29	28,640	
30	28,387	
Feb 5	25,898	
Mar 19	24,932	
Apr 13	25,243	
May 31	25,381	
Jun 6	28,945	
8	28,691	
9	28,945	
10	28,313	
11	28,062	
14	35,358	
15	28,062	
16	34,932	
17	39,357	
18	39,381	

*High water release for the year

	Date	c.f.s.	Lake Elevation	Date	c.f.s.	Lake Elevation
1980 Continued						
	Jun 23	44,907				
	*24	48,998	3700.21			
	25	31,160				
	26	37,661				
	27	37,786				
	28	37,912				
	29	37,661				
	30	37,661				
	Jul 1	37,786				
	2	37,410				
	3	31,892				
	4	30,418				
	5	30,543				
	6	30,418				
	7	30,167				
	8	29,813				
	10	28,313				
	11	28,187				
	12	28,313				
	16	28,438				
	22	28,187				
	Aug 9	28,691				
	18	28,309				
	22	28,181				
	Sep 5	27,290				
	Oct 6	24,872				
	Nov 15	25,448				
	Dec 10	27,515				
1981	Jan 20	24,932				
	Feb 1	26,869				
	Mar 30	18,925				
	Apr 3	22,482				
	May 5	20,068				
	Jun 29	20,450				
	Jul 20	28,935				
	29	28,290				
	Aug 3	26,773				
	Sept 9	26,160				

*High water release for the year

United States Department of the Interior

BUREAU OF RECLAMATION
UPPER COLORADO REGIONAL OFFICE
P.O. BOX 11568
SALT LAKE CITY, UTAH 84147

IN REPLY REFER TO: UC-150
651.

December 14, 1982

To: Government Agencies and Interested Organizations and Individuals:

In compliance with the National Environmental Policy Act, enclosed for your information is a copy of the Environmental Assessment and FONSI (Finding of No Significant Impact) for the powerplant uprating at Glen Canyon Dam.

The comments received on the Environmental Assessment circulated for public review on February 9, 1982, have been evaluated and incorporated into the Environmental Assessment. These comments, in conjunction with the evaluation of impacts, indicate that the preferred plan would not be a major Federal action resulting in significant environmental impacts; thus, a FONSI is appropriate.

I, therefore, have made the decision to proceed with the uprating of the generators at Glen Canyon Dam; however, because of the substantial number of responses to the Environmental Assessment which raised questions concerning the impacts of the operation of Glen Canyon Powerplant under present operating criteria, I have requested and received approval from the Office of the Secretary of the Interior (letter of December 6, 1982, attached) to initiate studies to determine the environmental effects of the present and historic operation of Glen Canyon Dam on the resources of the Grand Canyon. While these studies are underway and the work on the uprating of the generators is being done, the releases from Glen Canyon will be restricted to 31,500 ft^3/s, which is the historic operating maximum.

The studies will also undertake an analysis of potential alternative operating criteria consistent with the Colorado River Storage Project requirements. If any of the alternatives meet these requirements, an Environmental Impact Statement would be required in preparation for a decision process in determining the appropriate long-term operating criteria for Glen Canyon Powerplant.

Sincerely yours,

Clifford I. Barrett
Regional Director

Enclosures

United States Department of the Interior

BUREAU OF RECLAMATION
~~WATER AND POWER RESOURCES SERVICE~~

WASHINGTON, D.C. 20240

GLEN CANYON UNIT
RECEIVED ... CRSB
OFFICIAL FILE COPY
DEC 12 '82

Date	Initials	To
		150

Subs. Corresp.
Date Ans'd

742

IN REPLY
REFER TO: 150

DEC 6 1982

Memorandum

To: Regional Director, Salt Lake City, Utah

From: Commissioner

Subject: Uprating and Studies of Operational Alternatives--Glen Canyon Powerplant--Colorado River Storage Project (CRSP)

We have reviewed the proposed final Environmental Assessment/Finding of No Significant Impact (EA/FONSI) transmitted with your letter of October 27, 1982.

While we concur with your analysis of the potential environmental consequences of the proposed uprating and alternative courses of action, any decision by you to initiate the uprating program should take into account the following guidance:

1. The evidence presented indicates that the uprated generators are still economically viable if used only during maintenance activities or during emergencies and would provide greater flexibility even without any changes in current operating criteria. Consequently, the additional plant capacity resulting from the uprating will be restricted to present maximum water releases (31,500 ft ^{3}/s) from the powerplant. This restriction on operation of the uprated generators will remain in effect until a decision process, with appropriate NEPA compliance, has been completed on a long-term operating criteria for Glen Canyon Powerplant.

2. Studies will be undertaken on the current operation of Glen Canyon Dam to see how the present flow patterns impact upon the total riverine environment in the Grand Canyon and how various low-flow periods affect rafting and the fisheries resources in the river. We anticipate that these studies will evaluate various low-flow patterns, such as, 1,000, 3,000, 4,000, 5,000, and/or 8,000 ft ^{3}/s. We also anticipate that you will evaluate fluctuating patterns as well as periodic high-flow periods to see if there is a point where high flows materially affect beach erosion, recreation, and fisheries.

742

We concur with your initiation of the following studies:

a. Sediment transport-beach erosion studies below Glen Canyon Dam through the Grand Canyon.

b. Biological studies to determine what impacts are occurring based on the above sediment transport studies.

c. Environmental studies of the effects of the present and historic operation of Glen Canyon Dam on the vegetation, wildlife, fishery, recreation, and other environmental resources of the Grand Canyon.

These studies are to be conducted as a cooperative effort with the National Park Service (NPS), with the Bureau providing the funding, and being the lead agency. Other appropriate Federal and non-Federal agencies should also be requested to participate with the NPS and the Bureau in the above studies. We will need the assistance of the Fish and Wildlife Service in certain of these studies and a copy of this letter is being sent to the Director of the Fish and Wildlife Service to alert that agency of our decision and the need for its assistance.

3. In conjunction with these studies, you should undertake an analysis of potential alternative operating criteria, consistent with CRSP requirements, to see if there are feasible alternatives to our present operating criteria that will address the many concerns raised on our uprating environmental assessment. Should alternatives that meet the above criteria be identified, an environmental impact statement should be prepared. This would lead to a decision process to determine appropriate long-term operating criteria for Glen Canyon Powerplant.

Robert N. Broadbent

Concur:

Mary Lou Grier — 12/7/82

ACTING Director, National Park Service — Date

G. Craig Potter — 12/7/82

Assistant Secretary for Fish and Wildlife and Parks — Date

David L. Houston — 12/7/82

742 Deputy Assistant Secretary - Land and Water Resources — Date